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Sibling Gender Composition and Preferences for STEM Education

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Abstract

This paper studies how sibling gender composition affects preferences for education within Science, Technology, Engineering, and Mathematics (STEM). To identify the causal effect of sibling gender, I focus on a sample of firstborn children who all have a younger biological sibling. The randomness of the younger siblings' gender allows me to estimate the causal effect of having an opposite compared to same sex sibling. Overall, having an opposite sex sibling makes educational choices more gender-stereotypical for both genders. Having an opposite sex sibling reduces women's probability to enroll in any STEM program after compulsory schooling by two percent and to complete a STEM college major by nine percent. Men, in contrast, show an increased interest for the STEM field but are not more likely to succeed in high-level STEM programs. An important mechanism for these findings is changes in child-parent interactions. Parents with mixed sex children gender-specialize their parenting more and spend more quality time with their same sex child than parents with same sex children. Moreover, I show that young boys with an opposite sex sibling are exposed to more gender-stereotypical behavior within the family than boys with a same sex sibling.

JEL classification: I2, J1, J3

Keywords: Sibling gender composition, gender identity, gender-stereotype,STEM, education, field of study.

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1 Introduction

Although women today, on average, attain longer education than men across most OECD countries, large gender differences persist in the choice of field of study (OECD, 2016). Only 28 percent of students enrolled in tertiary education are female within Science, Technology, Engineering, and Mathematics (STEM), while women represent 54 percent of all students. In contrast, women dominate the Care fields, including Education, Health, and Welfare. Meanwhile, the returns to field of study vary as much as the returns to level of education with the greatest returns to the STEM field (Altonji et al., 2012; Kirkeboen et al., 2016). The gender segregation in field of study persists into occupational choice in the labor market and contributes thereby to the gender wage gap (Blau and Kahn, 2016; Gallen et al., 2017). At the same time, the STEM field is the major source of technological innovations, which in the long run represents the fundamental driver of economic growth.[1] Given the larger returns to STEM education than other fields both for the individual and society, an important challenge for policymakers is to attract more people —and in particular more women given their current underrepresentation —to the STEM field.

An improved understanding of why men and women continue to make gender-stereotypical choices is crucial if we want to design policies and interventions that can enhance students' interest in the STEM field. Some studies find that female STEM role models in high school and college make women more likely to choose a STEM college major (Bottia et al., 2015; Carrell et al., 2010). However, other studies do not find as convincing results (Bettinger and Long, 2005; Hoffmann and Oreopoulos, 2009). Moreover, the same sex education literature argues that especially girls taught in a single sex environment are less exposed to gender-stereotypical behavior and are therefore less inclined to acquire traditional gender norms (Booth et al., 2014; Schneeweis and Zweimüller, 2012). For instance, Favara (2012) shows that students attending single sex schools in the U.K. make less gender-stereotypical educational choices and that this effect is larger for girls than boys. Yet, we do not know much about the role of the family in the process of shaping preferences for the STEM field.[2]

This paper examines how sibling gender composition affects men and women's preferences for STEM education using Danish administrative data on cohorts born

[1]See, for instance, Atkinson and Mayo (2010); Peri et al. (2015) and references therein.

[2]Previous studies have mainly studied the association between sibling gender composition and educational attainment (Amin, 2009; Bauer and Gang, 2001; Butcher and Case, 1994; Conley, 2000; Cyron et al., 2017; Hauser and Kuo, 1998; Kaestner, 1997). The only exceptions are Anelli and Peri (2014) and Oguzoglu and Ozbeklik (2016) who study the probability to choose a male-dominated/STEM major. The former paper, however, suffers from major data limitations, as it only observes siblings completing an academic high school degree in Milan. The latter paper asks a much more narrow question whether STEM fathers differentially invest in their daughters depending on whether or not they also have at least one son; moreover, due to the very small sample size, the estimates are only imprecisely estimated.

between 1960 and 1988. To identify the causal effect of sibling gender, I focus on a sample of firstborn children who all have a younger biological sibling (same mother and father). Conditional on the first child's gender, the randomness of the younger siblings' gender allows me to estimate the causal effect of having an opposite sex sibling. The main finding is that having an opposite sex sibling increases the probability to choose a gender-stereotypical education and this effect persists into occupational choice and earnings in the labor market. Men with an opposite sex sibling have an increased preference for the STEM field; yet, they are not more able to succeed in high-level STEM programs. Women with an opposite sex sibling, in contrast, are more likely to opt out of STEM already at the time of high school application and they do not opt in again. This is an important finding for policy makers, as it emphasizes that women's choice *not* to study within the STEM field happens before exiting compulsory education.

The results are, broadly, comparable to other studies on field choice both in terms of the magnitude of the effects and in terms of finding largest effects for women. I find that having an opposite sex sibling decreases (increases) women's (men's) likelihood of having a highest completed degree within STEM by 4.4 (1.2) percent and completing a STEM college major by 8.6 percent; I do not find an effect on the latter for men. In comparison, Schneeweis and Zweimüller (2012) find that increasing the proportion of female peers in lower secondary education by one standard deviation decreases the probability that girls choose a typical female track by 11 percent. Similarly, Bottia et al. (2015) show that having a one standard deviation larger proportion of female math and science teachers in high school increases women's probability of graduating with a STEM college major by almost 10 percent (no effect for men). Finally, Carrell et al. (2010) find that a one standard deviation increase in the proportion of female math and science instructors in introductory courses in the U.S. Air Force Academy increases the probability that women with above median math ability graduate with a STEM major by 7.9 percent (no effect for women with low math ability or men).

Why does sibling gender alter men and women's likelihood to choose the STEM field? The impact on field choice could either be due to changes in preferences or ability. However, I rule out the latter, as sibling gender composition does not have an economically meaningful impact on school performance. Broadly, sibling gender might affect identity and thereby preferences through three distinct channels: child-parent interactions, child-sibling interactions, and societal norms. I explore these possible mechanisms and provide evidence that especially changes in child-parent interactions might play an important role for the changes in preferences: parents to mixed sex children gender-specialize their parenting more than parents to same sex children. This is also supported by the finding that the effects on STEM choice are strongest for individuals with a more “gender-stereotypical” same sex parent. Furthermore, in line with the same sex education argument, I only find significant effects for individuals with short spacing to their younger sibling. Finally, I show that young boys with an opposite sex sibling are more exposed to gender-stereotypical behavior within the family than boys with a same sex sibling, indicating a role of societal norms as well.

This paper makes four important contributions to the existing literature. First, I use a new strategy to estimate the causal effect of sibling gender compared to previous studies, which I argue suffer from selection bias.[3] Second, I study the effect on STEM preferences by providing a complete picture of the educational process from first place of enrollment after compulsory schooling (grade 9) through age 30; this is in contrast to the vast majority of the previous sibling gender composition literature examining effects on length of schooling. Third, I use a unique administrative dataset with complete information on parental fertility and children's educational history and labor market performance; the large sample size further ensures precisely estimated effects. Fourth, I exploit survey data to provide a more detailed picture of the channels through which the effects on STEM preferences operate.

This paper is organized as follows: Section 2 discusses challenges associated with the estimation of causal effects of sibling gender composition and presents an empirical strategy, overcoming such problems. Section 3 describes the data and the Danish educational system. Section 4 presents the main results on STEM education, followed by an examination of potential effects on educational attainment that could possibly blur effects on field of study and an examination of whether the effects persist into mid-career labor market outcomes. Section 5 reviews the literate in terms of relevant explanations for the observed effects on STEM preferences, followed by an empirical analysis of the mechanisms. Section 6 tests the robustness of the results in terms of alternative definitions of field of study and shows, furthermore, that family size does not confound the effects on sibling gender composition. Finally, Section 7 concludes.

2 Empirical Strategy

The aim of this study is to estimate the causal effect of having an opposite sex sibling. To do so, I estimate the effect of having a younger opposite sex sibling on a sample of firstborn children. This is a clean approach providing causal estimates, given the randomness of the second child's gender. This is contrary to previous studies examining sibling gender composition and educational attainment, as they generally include

[3]The only exception is Peter et al. (2015) that uses a different strategy but also convincingly estimates causal effects; however, that working paper studies the effect on educational attainment and not field of study.

all siblings both in the measure of sibling gender composition and in the estimation sample.[4] I start this section by explaining why considering the gender of older siblings might be problematic due to selection bias. Thereafter, I present the empirical specification for the analysis.

A general finding in developed countries is that parents have an increased probability of getting a third child if their first two children are of same compared to mixed gender (Angrist and Evans, 1998; Black et al., 2005). This implies that the gender composition of current children affects the decision to proceed to the next parity.[5] Thus, parents have preferences over the gender composition of their children. A parental preference for having at least one child of each gender could explain this fertility pattern. However, other types of preferences could explain the pattern as well. For instance, some parents might prefer boys, while others might prefer girls (Peter et al., 2015). If parents continue to get children until they have a child of their preferred gender, we would expect to see that parents with mixed sex children were less likely to get an additional child. Moreover, if the proportion of parents preferring a girl equals the proportion of parents preferring a boy, we would not expect to observe significant differences in the probability of having a second child by the first child's gender, on average.

Previous studies examining associations between sibling gender composition and educational outcomes have included children of all birth orders. This is, however, problematic because of selection bias and leads to biased estimates if parents with different gender preferences raise their children differently.[6] As an example, assume we want to estimate the effect of an older sibling's gender on the second-born child's outcome and that parents either prefer a girl, a boy, or are indifferent but just want two children. If we then estimate the effect of having an older brother compared to an older sister for the sample of second-born girls, Table 1 illustrates that girls with an older brother come from families who prefer girls or are indifferent, while girls with an older sister come from families who prefer boys or are indifferent. Thus, second-born girls who have an older brother do not, on average, come from similar family backgrounds as those who have an older sister. If parents with a certain gender preference raise their children of that gender more gender-stereotypically, we would expect the bias to

[4]The only study, which I am aware of, that does not include older siblings in their measure of sibling gender composition is Peter et al. (2015). Instead, that working paper investigates the effect of a co-twin's gender. In other words, it focuses on a much narrower group of people.

[5]Appendix Table A1 illustrates this with Danish data.

[6]Previous studies both include children of all birth orders in the empirical sample as well as in their measures of sibship gender composition. This approach is, furthermore, problematic because a child with a greater number of older siblings comes from a larger family and is of higher birth order, which is generally associated with worse educational outcomes (Black et al., 2005; Lehmann et al., 2016). Moreover, considering the effect of any sibling of a certain gender is naturally more likely in large sibship.

magnify the estimated effect of sibling gender.

Table 1
Example: Parental Gender Preference and Fertility Choice

Gender of 1^{st} child	Girl						Boy					
Gender Preference	Girl		Indif.		Boy		Girl		Indif.		Boy	
Get 2^{nd} child	no	no	yes	yes	yes	yes	yes	yes	yes	yes	no	no
			↓	↓	↓	↓	↓	↓	↓	↓		
Gender of 2^{nd}	G	B	G	B	G	B	G	B	G	B	G	B

Put differently, the selection bias problem arises because we only observe the outcome for second-born children who are actually born. To show this more formally, I here follow Peter et al. (2015). Assume a latent outcome $Y_i^* = \alpha + \beta G_i^{old} + X_i'\gamma + \epsilon_i$, where G_i^{old} is the gender of the older sibling and X_i is a vector of observable exogenous characteristics. ϵ_i contains other relevant unobservable variables, such as parental gender preferences denoted by P_i, and $E[\epsilon_i] = 0$. The bias arises because of the latent nature of Y_i^*, as we only observe the outcome if child i is born, i.e. $Y_i = Y_i^*$ if $S_i = 1$ and Y_i is missing if $S_i = 0$. The selection depends both on parental preferences and the older child's gender, $S_i = f(P_i, G_i^{old})$. We can only estimate the effect for the sample of children who are born which gives the expected value of Y_i:

$$
\begin{aligned}
E[Y_i|S_i = 1, G_i^{old}, X_i] &= \alpha + \beta G_i^{old} + \gamma X_i + E[\epsilon_i|S_i = 1, G_i^{old}, X_i] \qquad (1) \\
&= \alpha + \beta G_i^{old} + \gamma X_i + E[\epsilon_i|f(P_i, G_i^{old}) = 1, G_i^{old}, X_i].
\end{aligned}
$$

As long as selection depends on the first child's gender and parental preferences affect the way in which parents raise their children $E[\epsilon_i|f(P_i, G_i^{old}) = 1, G_i^{old} = 1, X_i] \neq E[\epsilon_i|f(P_i, G_i^{old}) = 1, G_i^{old} = 0, X_i]$. This implies that the estimate of the older sibling's gender is biased.

A selection problem could also arise in the absence of parental gender preferences. Assume that firstborn children have n traits that are normally distributed. These traits could be how easy the child is to take care of, how well it behaves, health endowments, etc. Parents only want a second child if their first child has a value of each trait above a certain threshold. The threshold for or the distribution of each trait could be gender-specific. In both cases, parents who progress to the next parity would, on average, have different types of first-born children depending on the child's gender. For instance, if boys and girls have the same distribution of how well they behave but parents require girls to behave better than boys before they get a second child, second-born children would, on average, have a better behaving older sibling if they have a sister compared to a brother. Therefore, the estimated effect of the older sibling's gender on the younger child's outcomes might be due to the older sibling's behavior rather than due to his or her gender.

As a consequence of the selection bias problem, we can only causally estimate the effect of "future" children's gender on "current" children's outcomes, because parents do not know the gender of a subsequent child when they make the decision to progress to the next parity. Thus, to circumvent the problem with selection bias, I estimate the effect of the second child's gender on the first child's outcomes. The identifying assumption is that conditional on the gender of the first child, the gender of the second child is as good as random. The empirical specification for the main analysis is:

$$Y_i = \alpha_0 + \alpha_1 Opposite\ Sex_i^{young} + X_i'\delta + \nu_i, \tag{2}$$

and is always estimated separately for men and women. Y_i indicates whether individual i studies within the STEM field and the estimate of interest is α_1, i.e. the effect of having a younger sibling of the opposite sex. X_i is a vector of fixed effects for birth municipality, year-by-month of birth, spacing in months to the younger sibling, immigrant status, maternal age at birth, paternal age at birth, maternal level-by-field of education[7], and paternal level-by-field of education. One caveat for this approach is that future children's gender still, on average, affects final family size. However, Subsection 6.2 provides rigorous evidence that family size does not confound the effect of sibling gender composition. Thus, the estimated effect is indeed the effect of sibling gender and is not purely an effect of family size.

3 Data

3.1 Data and Sample Selection

I use Danish administrative data for the total population from 1980 through 2015. One central feature of this dataset, compared to most previous studies, is that I can link all children to their parents and siblings. Thus, I observe parents' complete fertility history and thereby, correctly measure the sibling gender composition. Moreover, I have information on parents' date of birth; length, type, and field of education; labor market attachment; and occupation.[8] For the children, I observe every time a person enrolls in an education and have detailed information on the characteristics of the program, such as level, type, and field; this enrollment data is available since 1973.

[7] More precisely, I control for education level-by-field for the fields that are common for mothers, field without education level interactions for fields that are less common, and education level for all. This control approach is similar for fathers.

[8] The registers started to report occupation in 1991. To assess parental occupation, I use the mode occupation from 1991–2000.

The educational registry further reports the highest completed degree at an annual basis. Throughout, I follow the International Standard Classification of Education (ISCED) for the definition of all educational measures. Finally, I also observe the children's annual labor earnings and occupation.

I restrict the sample to cohorts born between 1960 and 1988 to allow for sufficient time to enroll and complete an education. Moreover, I only include firstborn children, who are the first child to both the mother and father; I exclude first generation immigrants to eliminate concerns about unobserved siblings in the data and because I might not observe all their educational history; I only consider individuals who have at least one full sibling (same mother and father) born less than five years apart and who survives the first year of life; I exclude families where either the first or second child is a twin; and finally, I exclude those few individual's who die before age 30 or do not live in Denmark at any time between age 25 and 30. I refer to this sample of firstborn children as the *main sample*.

Panel A in Table 2 provides descriptive statistics on demographic background characteristics of the main sample by gender. Men and women come, on average, from very similar family backgrounds. Average spacing to the younger sibling is a bit less than three years (33.7 months); one-third of the sample have at least two full siblings; and 1.2 percent are second generation immigrants. Mothers were on average 23.4 years at their first child's birth and fathers were 2.7 years older. Mothers have an average length of education of 11.2 years, while fathers have, on average, 0.8 years more. Parents' field indicates their field of education and in case they do not have a field-specific education, it indicates their field of occupation.[9] Nearly one-third of mothers are within care (education, health, and welfare) and another third are within administration.[10] In contrast, 8 percent of fathers are within care and 21 percent are within administration. Even within administration, parents tend to gender-segregate into gender-stereotypical subfields: the vast majority of mothers are within Secretarial and Office Work, Wholesale and Retail Sales, and Language Acquisition, while fathers tend to be within Accounting, Taxation, Finance, Banking, Insurance and Audio-visual Techniques and Media Production. Half the fathers are within STEM, while this is only the case for 11 percent of mothers. Thus, parents are strongly sorted into gender-specific fields.

Panel B in Table 2 shows statistics from a balancing test, testing whether the family background variables included in equation (2) can predict having a sibling of the opposite gender, conditional on birth municipality and year-by-month fixed effects.

[9] Around half the sample of parents, do not have a field specific education. Six percent of parents do not have an observed field (either education or occupation); they represent the omitted group.

[10] I define administration broadly such that it includes educations within Arts, Humanities, Social Sciences, Journalism, Information, Business, Administration, and Law. The majority of parents (around 80 percent) fall within the group of Business and Administration.

Table 2
Descriptive Statistics and Balancing Test by Gender

	Women		Men	
Panel A: Descriptive Statistics				
	Mean	SD	Mean	SD
Opposite Sex Sibling	51.15		48.71	
Spacing (months)	33.76	11.97	33.73	11.95
Spacing 9–23 months	22.45		22.48	
Spacing 24–35 months	34.74		34.79	
Spacing 36–47 months	27.50		27.49	
Spacing 48–59 months	15.31		15.24	
# of Full Siblings	1.44	0.71	1.45	0.71
2+ Full Siblings	34.53		35.49	
Mother's age at birth	23.39	3.73	23.42	3.74
Father's age at birth	26.15	4.44	26.15	4.43
Mother's Edu (years)	11.17	2.99	11.18	2.99
Father's Edu (years)	11.98	3.13	11.99	3.12
Mother STEM	10.82		10.87	
Mother Care	29.81		29.84	
Mother Administration	34.00		34.13	
Mother Service	17.94		17.82	
Mother Agriculture	2.07		2.06	
Father STEM	51.95		52.03	
Father Care	8.25		8.23	
Father Administration	20.68		20.94	
Father Service	6.17		6.08	
Father Agriculture	7.16		7.10	
Father Defense	0.35		0.37	
2^{nd} Gen. Immigrant	1.21		1.17	
Panel B: Balancing Test				
Joint F-statistic	1.02		1.03	
Prob > F	0.42		0.38	
N	228,856		240,902	

Note: Main sample. *SD* shows the standard deviation for non-binary variables. The means for binary variables are shown as percent. The balancing test tests whether family background characteristics (spacing in months to younger sibling, second generation immigrant status, maternal age at birth, paternal age at birth, maternal level-field of education, and paternal level-field of education) can predict having a younger opposite sex sibling. F-test of joint significance of all the family background characteristics.

More precisely, it reports the F-test of joint significance of all the family background characteristics in a regression where the outcome is an indicator for having a younger sibling of the opposite gender. The F-test strongly rejects joint significance both for the sample of men and women. Thus, this balancing test supports the identifying assumption that the younger sibling's gender is conditionally random.[11]

3.2 Education and Field of Study

In Denmark, all children are required to attend primary school from age 7 through grade 9 (or through the year the person turns 17 years).[12] In the final year of 9^{th} grade, students decide whether they want to enroll in an optional 10^{th} grade, which is formally a continuation of primary school, enter the labor market, or apply for secondary education.[13] Secondary education consists of two types: vocational training and academic high school. Within each of these types, students choose their broad field at the time of application. Vocational education covers most fields and for this type of education, I group Information and Communication Technologies, Engineering, Manufacturing, and Construction as STEM. The academic high school has overall four tracks (language, math, technical, and commercial), of which I group the math and technical tracks as STEM.

An academic high school diploma gives access to tertiary education. An application to tertiary education is an application to a specific program (e.g. bachelor in Physics at the University of Copenhagen). To enroll in most STEM programs at the tertiary level, students need to have taken certain STEM courses in high school, such as advanced Math and intermediate Physics and Chemistry. Therefore, an academic high school STEM diploma gives much easier access to STEM education at the tertiary level than other secondary school degrees. However, it is possible to take complementary courses after high school graduation to meet the admission criteria for STEM programs at the tertiary level. Moreover, some vocational degrees give access to tertiary level education within the same specific field. Acceptance to tertiary level programs mainly depends on the grade point average (GPA) from high school. Most STEM programs admit all eligible applicants (or have very low GPA cutoffs), meaning that once fulfilling the high school STEM course requirements, good prior school performance is not necessary for enrolling within the STEM field in higher education. Following the ISCED codes, I

[11] The event study graphs in Appendix Figure A4, described in Subsection 6.1, further show that parents do not differ in terms of socio-economic characteristics by the gender composition of their children before or around the birth of their first child.

[12] For the cohorts of study, it was common to attend a so-called kindergarten class the year before starting first grade, although it was not mandatory.

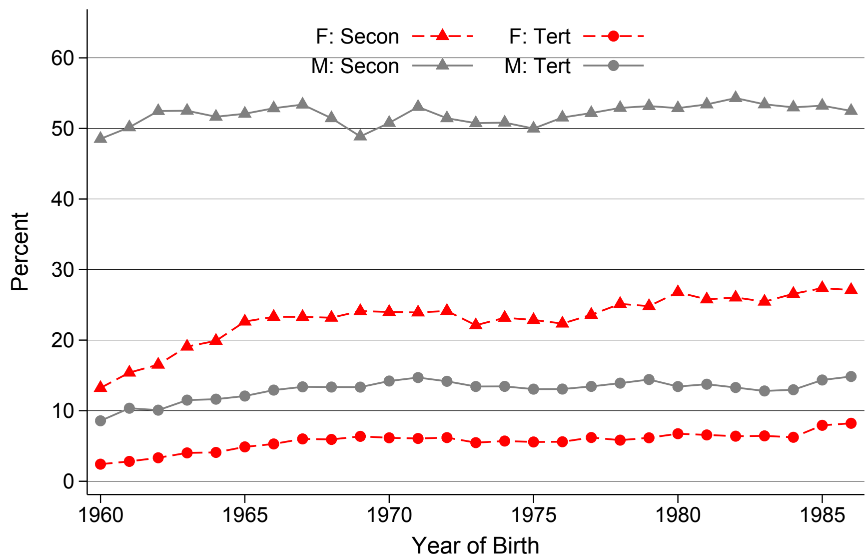
[13] After the optional 10^{th} grade, students again have the choice between academic high school and vocational training if they wish to pursue secondary education. For the analysis, I restrict the attention to enrollment in and completion of programs after primary school, i.e. after grade 9 and 10.

define the STEM field in tertiary education as Natural Sciences, Mathematics, Statistics, Information and Communication Technologies, Engineering, Manufacturing, and Construction.

Figure 1 shows the share of a cohort completing any STEM degree by gender over time. Despite large changes in educational attainment across these cohorts[14], the share of a cohort completing a STEM degree at the secondary and tertiary level has been surprisingly stable across all cohorts for both genders. Approximately 53 (24) percent of men (women) complete a secondary STEM degree and 13 (6) percent complete a STEM degree at the tertiary level.

Figure 1

Completing a STEM Degree at the Secondary and Tertiary Level at Age 30 by Gender Across Cohorts



Note: Main sample. The graph illustrates the share of a cohort completing a STEM degree at the secondary (vocational or academic) and tertiary level, restrictively. *F* in the labels refers to *female* and *M* to *male*.

To not potentially confound the results on STEM preferences with educational attainment, the main outcomes consider STEM education at any level after primary school. This is a valid approach, as I show that sibling gender composition does not affect the probability of ever enrolling in or completing a secondary education.[15] For all educational measures, enrollment includes observations through age 27 and completion through age 30, to give people time to complete the education in which they enroll.

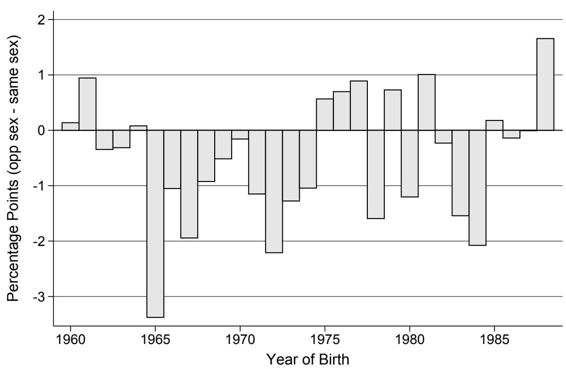
[14]See Appendix Figure A1.

[15]See Table 6.

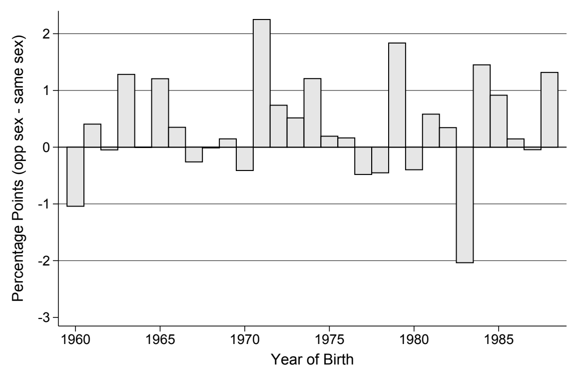
The main analysis of STEM education considers six binary outcomes, measuring the probability that the individual: 1) enrolls in a STEM program as the first place of enrollment after primary school; 2) ever enrolls in a STEM program; 3) ever completes a STEM degree; 4) has the highest completed degree within STEM; 5) has a highest completed education within STEM that is directly preparing for the labor market (*STEM Work Prep*)[16]; and 6) enrolls in a STEM program at a higher educational level than the highest level he or she ever completes (STEM Dropout). As a complementary analysis, I also consider the probability of ever enrolling in and completing a secondary vocational-, academic high school- and tertiary STEM program.

Figure 2

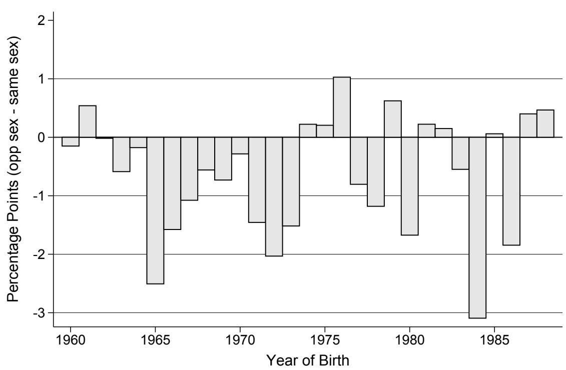
STEM Education by Gender Across Cohorts: Opposite-Same Sex Sibling Differences



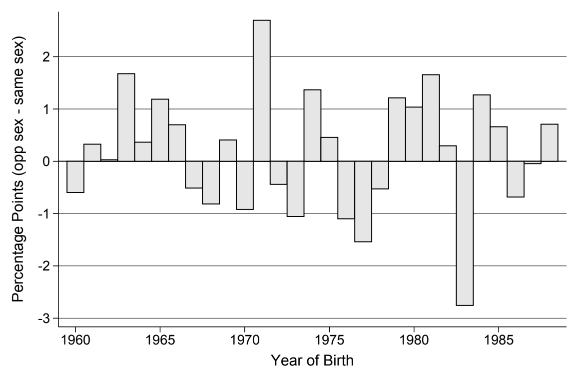
(a) Women: Any Enr



(b) Men: Any Enr



(c) Women: Any Compl



(d) Men: Any Compl

Note: Main sample. All graphs show the difference between individuals with an opposite sex sibling and individuals with a same sex sibling. Graphs (a) and (b) illustrate the difference in the share of each cohort enrolled in any STEM degree, while Graphs (c) and (d) illustrate the difference in the share of each cohort completing any STEM degree.

[16]This measure excludes academic high school STEM degrees, as they only prepare for higher education and not for a specific job.

Figure 2 provides some first evidence on the effect of sibling gender composition on STEM choice. Each graph illustrates, by cohort, the raw difference between the share of individuals who enroll in or complete any STEM program with a sibling of the opposite gender and those with a sibling of the same gender. For women, the overall pattern is clear, showing that those with a brother are both less likely to ever enroll in and complete a STEM program compared to women with a sister. On average, these differences are 0.55 and 0.64 percentage points for respectively enrollment and completion and are statistically significant at the one percent level. In contrast, the pattern is more noisy for men, though indicating that men with a sister compared to a brother are more likely to ever enroll in and might be more likely to complete a STEM program. The difference for any enrollment in (completion of) a STEM program between men with an opposite sex sibling and men with a same sex sibling is 0.33 (0.21) percentage points with a p-value of 0.08 (0.30).

4 Results

This section presents the results from the main analysis. Subsection 4.1 studies the effect of having an opposite sex sibling on preferences for STEM education by considering STEM enrollment and completion at any level; it further provides a more detailed picture of the educational processes from secondary to tertiary STEM education. Subsection 4.2 considers potential effects on educational performance —to assess whether the effects on STEM education are due to changes in preferences or ability —and educational attainment —to ensure that the effects are not driven by people who never enroll. Finally, Subsection 4.3 investigates the persistence of the effects by studying occupational choice and earnings in the labor market well into people's mid-career.

4.1 STEM Education

Table 3 shows the main results on sibling gender composition and STEM education by gender. Women with an opposite sex sibling are less likely to ever enroll in and complete any type of STEM education. Column (1) shows that women with an opposite sex sibling are 0.63 percentage points less likely to enroll in a STEM program as their first place of enrollment after compulsory schooling. Comparing this decreased probability to the mean of women with a same sex sibling of 27.6 percent gives a reduced probability of 2.3 percent (this statistic is indicated as *Pct. Δ rel. to SS* in the table). Most of this effect remains when considering the probability of ever enrolling in a STEM program [Column (2)]. Not only are women with a gender-discordant sibling less likely to enroll in a STEM education, yet, they are also less likely to complete such an education. The probability that women with a younger brother have their highest completed education

Table 3
STEM Enrollment and Completion at Any Level

	STEM Enrollment		STEM Completion			
	First	Any	Any	Last	Work Prep	STEM Dropout
	(1)	(2)	(3)	(4)	(5)	(6)
Women						
Opposite Sex Sib	-0.63***	-0.56***	-0.67***	-0.45***	-0.35***	-0.02
	(0.19)	(0.20)	(0.18)	(0.13)	(0.11)	(0.09)
Same Sex Mean	27.6	33.4	24.2	10.2	8.3	5.6
Pct. Δ rel. to SS	-2.3	-1.7	-2.8	-4.4	-4.2	-0.4
N	228,856					
Men						
Opposite Sex Sib	0.39*	0.42**	0.29	0.47**	0.27	0.38***
	(0.21)	(0.20)	(0.20)	(0.20)	(0.20)	(0.13)
Same Sex Mean	59.8	66.8	52.8	40.8	36.9	14.3
Pct. Δ rel. to SS	0.7	0.6	0.5	1.2	0.7	2.7
N	240,902					

All estimates are multiplied by 100. Standard errors in parentheses, clustered at the year-month of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Main sample. Each Panel-Column presents estimates from separate regressions. All models absorb fixed effects for birth municipality, year-month of birth, spacing in months to younger sibling, second generation immigrant status, maternal age at birth, paternal age at birth, maternal level-field of education, paternal level-field of education, and age at last educational observation.

within the STEM field and that the degree is directly preparing for the labor market is respectively 4.4 and 4.2 percent lower compared to women with a younger sister [Columns (4) and (5)].

In contrast, men with an opposite sex sibling are more likely to ever enroll in and, to some extent, complete an education within the STEM field. The probability to enroll in a STEM program as the first place of enrollment is 0.39 percentage points higher for men with a younger sister compared to those with a younger brother. However, this effect only represents a relative change of 0.7 percent compared to the mean for men with a same sex sibling. The difference between men with a brother compared to men with a sister is not statistically significant once considering the probability of completing any STEM education or that the highest completed education is a STEM degree preparing for the labor market [Columns (3) and (5)]. Meanwhile, having an opposite sex sibling still increases the probability that men have their last completed education within the STEM field by 1.2 percent [Column (4)]. This result is driven by an increased probability that men with an opposite sex sibling only complete an academic STEM high school degree.

The results on STEM dropout illustrate an important finding for men [Column (6)]. Having a gender-discordant sibling induces more men to enroll in a STEM program that is at a higher level of education than the highest level of education they ever complete. This implies that these men are more likely to dropout of a STEM program and never complete another field of study at the same educational level. Thus, the results overall suggest that men with an opposite sex sibling experience some kind of mismatch to a larger degree than men with a same sex sibling. As Table 5 shows in the next subsection, sibling gender composition does not affect school performance. Taken together, the results, therefore, support an interpretation of changed preferences for the STEM field, but that sibling gender does not improve men's ability to actually succeed in high-level STEM programs. In contrast, there is no effect on STEM dropout for women. Yet, this is still compatible with a story about preferences, as it is much harder to switch from non-STEM to STEM than vice versa.

To elaborate on the main results, Table 4 distinguishes between the level and type of STEM enrollment and completion. At the secondary level, sibling gender does not alter women's probability to enroll in or complete a traditionally very male-dominated vocational STEM program [Columns (1) and (2)]. In contrast, having an opposite sex sibling makes women almost four percent less likely to complete an academic high school STEM degree [Column (4)]. This consequently translates into a lower probability of both enrolling in and completing a tertiary STEM program by respectively 5.9 and 8.6 percent compared to the mean for women with a same sex sibling [Columns (5) and (6)]. Thus, these results together with those in Table 3 show that once women have

Table 4

STEM at Secondary (Vocational vs Academic) and Tertiary Level

	Voc Secondary		Acad HS		Tertiary	
	Enr	Compl	Enr	Compl	Enr	Compl
	(1)	(2)	(3)	(4)	(5)	(6)
Women						
Opposite Sex Sib	0.10	0.07	-0.73***	-0.71***	-0.48***	-0.50***
	(0.12)	(0.07)	(0.18)	(0.16)	(0.11)	(0.09)
Same Sex Mean	8.5	3.2	25.3	20.0	8.2	5.8
Pct. Δ rel. to SS	1.2	2.2	-2.9	-3.6	-5.9	-8.6
N	228,856					
Men						
Opposite Sex Sib	0.42**	0.35*	0.19	0.03	0.33**	0.06
	(0.19)	(0.18)	(0.20)	(0.16)	(0.14)	(0.13)
Same Sex Mean	39.5	28.0	34.7	24.6	17.6	12.8
Pct. Δ rel. to SS	1.1	1.3	0.5	0.1	1.9	0.5
N	240,902					

All estimates are multiplied by 100. Standard errors in parentheses, clustered at the year-month of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Main sample. Each Panel-Column presents estimates from separate regressions. All models absorb fixed effects for birth municipality, year-month of birth, spacing in months to younger sibling, second generation immigrant status, maternal age at birth, paternal age at birth, maternal level-field of education, paternal level-field of education, and age at last educational observation.

opted *out* of the STEM field—which already happens as an active choice at the time of high school application—they do not generally opt *in* again. This is a relevant finding for policy makers, as it stresses that women's choice not to study within the STEM field is made before exiting compulsory education.

For men, the story is different. Having an opposite sex sibling increases the likelihood that men enroll in a vocational STEM education at the secondary level by 0.42 percentage points (1.1 percent) and that they complete such program by 0.35 percentage points (1.3 percent); this latter effect is only borderline significant, though. The shift towards STEM at the secondary level only exists for vocational training, i.e. not for academic high school. Meanwhile, men with an opposite sex sibling are more likely to enroll in a tertiary STEM program. This indicates that for those men going in the academic direction, we also observe changed preferences for the STEM field. Importantly, however, sibling gender does not make men more or less likely to complete a tertiary education within STEM. Thus, although men with a sister instead of a brother are more likely to enroll in a STEM major in tertiary education, they are no more likely to complete such education.

In conclusion, having a sibling of the opposite gender makes the educational choice more gender-stereotypical for both men and women. Men have an increased preference for the traditionally very male-dominated vocational STEM programs as well as STEM majors in tertiary education. However, they are not, on average, more likely to complete a STEM degree that directly prepares for the labor market. This is due to an increased dropout rate from high-level STEM programs, leaving relatively more men with an academic high school STEM degree as their highest level of completed education. Similarly, women with an opposite sex sibling are less likely to choose programs in which their gender is typically underrepresented and they are also less likely to complete such programs. Thus, the effect on STEM enrollment in high school for women persists into the probability of completing a high school STEM program, which in turn translates into a natural shift away from STEM in tertiary education. The change in women's preferences for the STEM field in tertiary education is particularly large.

4.2 Educational Performance and Attainment

The results on STEM education are consistent with an interpretation about changed preferences. Yet, ability might potentially also play a role for the decision to study within the STEM field. When playing together, siblings might specialize within the field in which they have their comparative advantage, which in turn might affect their academic performance and thereby the possibilities of studying within the STEM field. This explanation is, however, not supported by the data. Panel A in Table 5 shows that sibling gender composition does not affect the probability of being observed with a grade from the 9^{th} grade written exam in Danish or Math or with a GPA from the academic high school. Panel B provides the results on academic performance, conditional on being observed with the particular GPA measure. Girls with an opposite sex sibling perform, on average, slightly worse than those with a sibling of the same gender. The effect is, nevertheless, not economically meaningful —1.0-1.6 percent of a standard deviation—and the effects are similar for language and math performance. At the same time, there is no effect for men. Consequently, these results do not support that ability should be the mechanism for the changed pattern of STEM choice.

Table 5

Educational Performance

	Girls			Boys		
	Grade 9 wr exam		Ac HS	Grade 9 wr exam		Ac HS
	Danish	Math	Dipl	Danish	Math	Dipl
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Probability of having GPA observation						
Opposite Sex Sib	-0.04	-0.08	-0.28	-0.07	0.00	-0.15
	(0.16)	(0.17)	(0.19)	(0.18)	(0.18)	(0.17)
N	109333	109333	228856	116212	116212	240902
Mean	91.5	90.7	51.8	87.6	87.4	34.3
Panel B: GPA *(Standardized for the total Population with Mean 0, SD 100)*						
Opposite Sex Sib	-1.09**	-1.03*	-1.56***	0.21	0.51	0.48
	(0.54)	(0.55)	(0.54)	(0.56)	(0.55)	(0.69)
N	99995	99207	118503	101796	101599	82520
Mean	40.5	17.9	3.9	-3.5	27.5	6.4

All estimates are multiplied by 100. Standard errors in parentheses, clustered at the year-month of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Main sample for the academic high school outcomes; children born between 1986 and 1998 with the same selection criteria as for the main sample for the grade 9 outcomes. Each Panel-Column presents estimates from separate regressions. All models absorb fixed effects for birth municipality, year-month of birth, spacing in months to younger sibling, second generation immigrant status, maternal age at birth, paternal age at birth, maternal level-field of education, and paternal level-field of education. *Ac HS Dipl* takes the value one if the individual has an observed academic high school GPA; for students completing before 1999, this is only observed for those in the language and math tracks.

Table 6

Educational Attainment by Age 30

		Secondary				Tertiary		
	Length (months)	Enr	Compl	Voc Compl	Ac Compl	Enr	Compl	Drop-out
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Women								
Opposite Sex Sib	-0.28***	-0.02	-0.10	0.28	-0.62***	-0.31*	-0.48***	0.17*
	(0.11)	(0.10)	(0.14)	(0.19)	(0.19)	(0.17)	(0.18)	(0.10)
Same Sex Mean	161.5	94.5	85.0	35.0	59.9	51.4	43.8	7.7
Pct. Δ rel. to SS	-0.2	0.0	-0.1	0.8	-1.0	-0.6	-1.1	2.2
N	228,856							
Men								
Opposite Sex Sib	-0.24**	-0.13	-0.23	-0.04	-0.32*	0.14	-0.20	0.33***
	(0.12)	(0.09)	(0.16)	(0.21)	(0.18)	(0.19)	(0.19)	(0.11)
Same Sex Mean	158.5	94.2	82.1	46.6	42.3	40.4	32.4	7.9
Pct. Δ rel. to SS	-0.2	-0.1	-0.3	-0.7	-0.1	0.3	-0.6	4.2
N	240,902							

All estimates are multiplied by 100. Standard errors in parentheses, clustered at the year-month of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Main sample. Each Panel-Column presents estimates from separate regressions. All models absorb fixed effects for birth municipality, year-month of birth, spacing in months to younger sibling, second generation immigrant status, maternal age at birth, paternal age at birth, maternal level-field of education, paternal level-field of education, and age at last educational observation.

The observed effects on STEM choice could potentially simply be due to an effect on the probability of enrolling in any type of education or in an education at a certain level. Table 6 shows the effects on educational enrollment and attainment. Overall, the effects on length of highest completed education by age 30 are economically insignificant: having an opposite sex sibling decreases men and women's length of education by eight days on average. Moreover, there is no effect on the probability of secondary enrollment or completion, thereby showing that sibling gender does not alter the probability of ever enrolling in or completing any type of education after compulsory schooling.[17] Thus, potential effects of sibling gender composition on educational attainment cannot drive the main results.

Despite being negligible in magnitude, both genders with a sibling of the opposite gender experience a decreased probability of completing an academic secondary degree. For men, the effect size is comparable to the increased probability of completing a secondary vocational STEM program, while for women it is close in magnitude to the negative effect on the probability of completing an academic high school STEM degree. Though again small in magnitude, women are also slightly less likely to enroll in (0.6 percent) and complete (1.1 percent) a tertiary degree; these effects are not significant for men. Meanwhile, especially men are more likely to drop out of tertiary education (4.2 percent). This finding is consistent with men's increased probability of dropping out of high-level STEM programs and that they are only more likely to enroll in but not more likely to complete a STEM tertiary education. Consequently, the effects of sibling gender composition on educational attainment are, overall, very small in magnitude and not of economic significance.

4.3 Labor Market Outcomes

A relevant question is whether the effects on STEM preferences in education persists into labor market outcomes. To study this, I follow people well into their mid-career by observing their occupational choice and annual labor earnings at age 30, 35, and 40. I restrict the main sample to cohorts born between 1960 and 1977; however, the results for the age 30 outcomes are similar when including all cohorts. I define an individual to be in a STEM occupation if the mode occupation in a five year period around the indicated age is within the STEM field.[18] Moreover, I consider the effects on the earnings percentile by age and cohort as well as the natural logarithm of earnings. The advantage of the former earnings measure is that it provides a standardized measure of

[17] Moreover, I do not find any effect on the probability of ever completing grade 9 or completing grade 9 on time (not reported).

[18] I use the Danish version of the International Standard Classification of Occupations (DISCO) to determine the occupations that are within STEM.

relative earnings that includes individuals with zero earnings and is comparable across cohorts and age.

Table 7 provides the results on labor market outcomes. The first three columns show the effect of having an opposite sex sibling on the probability of being employed in a STEM occupation. For women, the effects on STEM education translates nicely into a lower probability to work within the STEM field. Women with a gender-discordant sibling are respectively 2.9 and 4.4 percent less likely to work in a STEM occupation at age 30 and 40; this is very comparable to the decrease of 4.4 percent in the probability to have the highest completed education within STEM. In contrast, men do not experience a significant increase in the probability to work within STEM at age 30 or 35 (however, the estimated sign is positive and the effect is not a tight zero). Yet, this is in line with the finding that sibling gender does not affect men's likelihood of having a highest completed education preparing for the STEM field in the labor market. Meanwhile, at age 40, men with an opposite sex sibling experience an increased probability to work within STEM. Consequently, these results suggest that the changes in preferences for STEM education carry over into the labor market for both genders.

Both men and women experience a negative effect of having an opposite sex sibling on earnings. The effect on the earnings percentile by age and cohort is very stable across ages and similar in magnitude of around one-third of a percentile for both genders [Columns (4) to (6)]. This effect translates into a decrease in labor earnings by approximately one percent [Columns (7) to (9)]. As the previous results have shown, women with a sibling of the opposite gender are less likely to attain a (higher paying) STEM major in college; are less likely to work within the (higher paying) STEM field; and experience overall a small shift from academic to vocational education. Similarly, the results for men have shown that having an opposite sex sibling induces more men into vocational rather than academic secondary education; that those who enter tertiary education are more likely to drop out; and that they are more likely to drop out of high-level STEM programs and never complete a degree within another field at the same educational level. Based on these findings, it is not surprising that both men and women with an opposite sex sibling earn less on average.

Table 7

STEM Occupation and Annual Labor Earnings

	STEM Occupation			Earnings Percentile			Log(Earnings)		
Age	30	35	40	30	35	40	30	35	40
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Women									
Opposite Sex Sib	-0.37**	-0.38**	-0.53***	-0.24*	-0.32***	-0.33***	-0.77	-0.83*	-1.26***
	(0.17)	(0.16)	(0.15)	(0.13)	(0.12)	(0.12)	(0.55)	(0.47)	(0.47)
Same Sex Mean	12.8	12.6	12.0	45.7	45.9	47.5	1215.3	1236.5	1252.1
Pct. Δ rel. to SS	-2.9	-3.0	-4.4	-0.5	-0.7	-0.7	-0.1	-0.1	-0.1
N	142051	150921	145783	162545	160943	159646	141390	143823	144492
Men									
Opposite Sex Sib	0.34	0.40	0.53**	-0.33**	-0.35***	-0.35***	-0.73	-1.11**	-0.79
	(0.26)	(0.25)	(0.25)	(0.14)	(0.13)	(0.13)	(0.49)	(0.46)	(0.51)
Same Sex Mean	51.5	52.8	51.8	63.3	63.7	62.7	1253.3	1274.4	1283.4
Pct. Δ rel. to SS	0.7	0.8	1.0	-0.5	-0.5	-0.6	-0.1	-0.1	-0.1
N	148103	156709	150100	170881	169172	167144	157490	156000	153543

All estimates are multiplied by 100. Standard errors in parentheses, clustered at the year-month of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Main sample restricted to cohorts born between 1960 and 1977. Each Panel-Column presents estimates from separate regressions. All models absorb fixed effects for birth municipality, year-month of birth, spacing in months to younger sibling, second generation immigrant status, maternal age at birth, paternal age at birth, maternal level-field of education, paternal level-field of education, and age at last observation for the specific outcome.

5 Mechanisms

5.1 Possible Mechanisms?

So far, I have documented that the sibling gender composition in a family does matter for the formation of preferences for STEM education. But *why* does sibling gender change men and women' preferences for the STEM field? —a field that is gender-stereotypical for men and the opposite for women. To investigate this question further, this subsection draws on the literature to identify relevant mechanisms. Overall, I consider changes in identity —which we alternatively might label *attitudes* or *perceptions* —to be the reason for the altered preferences.[19] The overarching argument, concerning how sibling gender composition affects identity, is that individuals with an opposite gender sibling are more exposed to gender-stereotypical behavior and are therefore more disposed to acquire traditional gender norms. For this study, three distinct sources of change in identity are relevant to consider: societal norms, child-sibling interactions, and child-parent interactions.[20]

First, societal norms might be at play. Having a sibling of the opposite gender might increase the child's awareness of its own gender at an earlier age or to a larger degree. As an example, hearing the comment "you are a good girl" could affect girls differently depending on their sibling's gender. The girl with a brother might perceive the word *girl* as something being in contrast to *boy* and make her think about differences between girls and boys, while the girl with a sister might simply understand *girl* as meaning *child*. Thus, even if sibling gender composition were to have no impact on how siblings interact and how parents treat their children, we might observe changes in preferences due to cultural norms in society. This mechanism is, however, extremely difficult if not impossible to test for.

Second, parents might interact differently in terms of time spent and type of activities done with children depending on their children's gender composition. McHale et al. (2003) suggest that because parents of mixed gender children have the opportunity to gender-differentiate their parenting, children with opposite gender siblings might have the strongest explicit gender-stereotypes. For instance, Endendijk et al. (2013) find some evidence that fathers with mixed sex children exhibit stronger gender-stereotypical attitudes than fathers with same sex children. Moreover, previous research has documented that, overall, mothers talk more in general and more about interests and attitudes with daughters than sons (Maccoby, 1990; Leaper et al., 1998;

[19]Note, that the observed effect of sibling gender composition could either go through preferences or ability. However, as sibling gender does not have any economically significant effect on ability, I do not discuss this channel further.

[20]Appendix A.1 provides a short overview of alternative mechanisms discussed in previous papers on sibling gender composition. These mechanisms are, however, not compatible with the empirical findings.

Noller and Callan, 1990). Fathers, in contrast, talk more and spend more time with sons than daughters and have a greater emotional attachment to sons (Morgan et al., 1988; Noller and Callan, 1990). Fathers are further more involved in the family and spend more time with their children if they have at least one son [for references, see Lundberg and Rose (2003)]. Thus, parents might gender-specialize their parenting more when having mixed sex children. This, in turn, would make parental time use and investment more gendered. Consequently, taken together, these different pieces of evidence suggest that children with an opposite sex sibling compared to those with a same sex sibling develop stronger attitudes about gender due to differences in child-parent interactions.

Third, the child and its sibling might interact differently depending on their gender composition. In particular, having a sibling of the opposite gender might make children more aware of "appropriate" behavior for their own gender —such as "boys play with cars and girls play with dolls"—and thereby induce them to develop more gender-stereotypical attitudes and preferences. The overall mechanism is in line with the same sex education literature. The argument in this literature is that children, especially girls, acquire less gender-stereotypical interests when being together with only same gender children in the classroom (Booth et al., 2014; Schneeweis and Zweimüller, 2012).[21] Previous studies show that same sex education makes girls relatively more risky (Booth et al., 2014), that women tend to be less competitive when facing male competitors (Niederle and Vesterlund, 2011), and that the STEM field is perceived as more competitive (Buser et al., 2014). Moreover, Favara (2012) shows that students attending single sex schools in the U.K. make less gender-stereotypical educational choices and that this effect is larger for girls than boys. Therefore, having a sibling of the opposite gender might induce individuals —particularly women —to develop more gender-stereotypical preferences for the STEM field due to a greater awareness of gender through sibling interactions. This mechanisms is compatible with the results presented in the previous section.[22]

In Sum, a particularly important mechanism of the observed effect of sibling gender on preferences for the STEM field —that is possible to test for empirically—is differences in child-parent interactions. In the remaining of this section, I explore this mechanism further. First, if parents gender-specialize their parenting more when having mixed sex children, we would expect the effects of sibling gender on gender-

[21] A further argument is that girls will perform better, especially in male-dominated subjects, when taught in same sex classrooms. Some studies find improved (math) achievement among girl in same sex education and show evidence that mechanisms are a reduction in stereotype threat (Booth et al., 2013), improved self-confidence, and a more accurate self-assessment of math skills (Eisenkopf et al., 2015). However, other studies do not find an effect of same sex education on educational achievement (Doris et al., 2013; Jackson, 2012; Halpern et al., 2011).

[22] Meanwhile, it is difficult to formally test for this mechanisms.

stereotypical preferences to be stronger for individuals who have a same gender parent with more gender-stereotypical human capital. Second, in the extreme case of parental separation, we might expect that mixed sex children would be more likely to live with their same sex parent compared to same sex children. Third, in the much less extreme case, in the daily child-parent interactions, we might observe that same gender parents to mixed sex children invest more quality time in their same sex child. Thus, common for these predictions is that same gender parents would influence their same gender child more when having mixed sex children. Forth, we might observe that mixed sex children exhibit more or are to a larger extent exposed to gender-stereotypical behavior due to differential parental behavior and societal norms.

5.2 Heterogeneity

This subsection investigates whether the effects of sibling gender composition are heterogeneous by spacing to the younger sibling, decade of birth, and parents' length and field of education.[23] In terms of the former, Appendix Table A2 shows that there is no effect for those with spacing longer than five years; Appendix Figure A2 illustrates this for the probability of any STEM enrollment and completion. Meanwhile, the estimated effects by spacing are not statistically significantly different from each other, probably due to the small fraction of children with very long spacing to their younger sibling. Moreover, despite large changes in society over these 29 birth cohorts, the effects do not differ systematically by decade of birth (Appendix Table A3). This is consistent with the finding by Haines et al. (2016) that gender-stereotypes have not changed over the last three decades in the U.S.

Table 8 studies heterogeneity by parental length of education.[24] For women, the effect of having a sibling of the opposite gender is mainly concentrated among those with a high educated mother ($\geq$ 12 years of schooling) and especially among those where the father has short education ($<$ 12 years of schooling). This latter result shows that in families where parental human capital is proportionally more female —as most mothers with long education will be within a female-dominated field—the effects of having an opposite sex sibling on gender-stereotypical choices of education are even stronger. Moreover, the general finding that the effect is greatest for high educated mothers is compatible with the argument that mothers of mixed sex siblings specialize more in the daughter and that more gender-stereotypical mothers influence their daughters more

[23]Additionally, I have examined whether the effects are heterogeneous in the parents' division of labor during childhood and find no differences between individuals with parents who have a traditional division of labor (proxied by paternal labor supply representing at least 80 percent of total parental labor supply during childhood) and those with a less traditional division of labor (not reported).

[24]Appendix Table A4 shows heterogeneity by parental type of education (low, vocational, academic) with very similar results.

gender-stereotypically. In contrast, the effect for men is concentrated among those with a gender-stereotypical combination of parental education (high educated father and low educated mother). Consequently, both men and women who have a high educated same sex parent —and especially in families with a greater share of same gender human capital —experience the largest effects of sibling gender.

Table 9 explores whether the effects are heterogeneous in the parents' field. For women, the effects are concentrated among those with a mother within administration —in other words, among those mothers who are within a very female-dominated field. Meanwhile, the father's field is not important for women. In contrast, for men the effect is concentrated among those with fathers within the STEM field and administration. That the effects are especially large for fathers within administration might seem contra-intuitive at first glance. However, most fathers within administration are within more male-dominated subfields, such as finance and banking rather than secretary and office work. Although only being statistically significant for tertiary STEM enrollment, the results suggest that men with a father within the care field, which is heavily female-dominated, are in fact less likely to choose the STEM field when having an opposite sex sibling. Thus, these results are closely consistent with the findings on heterogeneous effects in length of parental education: the effect of having a sibling of the opposite gender is concentrated among individuals with a same sex parent with more gender-specific human capital and overall, the human capital of the opposite sex parent seems unimportant.

Consequently, the results from these heterogeneity analyses support the hypothesis that parents of mixed sex children gender-specialize the parenting of their children more than parents of same sex children. More precisely, if the same sex parent of mixed sex children invests more quality time in his or her same sex child than a parent of same sex children, we would expect that parents with more gender-stereotypical human capital (measured by length and field of education) would reinforce gender-specialization to a larger extent than those parents with less gender-specific human capital. This prediction is consistent with the empirical finding that the effects of sibling gender are greatest for children of more gender-stereotypical same sex parents. Thus, these heterogeneity analyses indicate that differences in child-parent interactions are important for the effects of sibling gender composition on STEM preferences. At the same time, the finding that individuals with long spacing to their younger sibling do not experience an effect of sibling gender might indicate the importance of sibling interactions. However, this finding could as well be because parents with children spaced far apart do not treat the firstborn child differently depending on the younger sibling's gender.

Table 8

STEM Education: Heterogeneity by Length of Parental Education

		Women					Men				
		Any STEM		Drop-	STEM Tert		Any STEM		Drop-	STEM Tert	
		Enr	Com	out	Enr	Com	Enr	Com	out	Enr	Com
	Pct.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Opp$\times M_{<HS}, F_{<HS}$	22	0.58	0.01	0.48**	0.05	0.08	-0.29	-0.01	-0.05	-0.02	-0.08
		(0.42)	(0.37)	(0.21)	(0.24)	(0.21)	(0.41)	(0.43)	(0.31)	(0.33)	(0.29)
Opp$\times M_{\geq HS}, F_{<HS}$	9	-1.47**	-1.59***	-0.10	-1.07***	-1.08***	0.08	0.26	0.62	1.18**	0.21
		(0.65)	(0.58)	(0.32)	(0.38)	(0.32)	(0.64)	(0.68)	(0.48)	(0.51)	(0.45)
Opp$\times M_{<HS}, F_{\geq HS}$	25	-0.73*	-0.54	-0.16	-0.41*	-0.44**	1.21***	0.75*	0.75**	0.62**	0.27
		(0.40)	(0.35)	(0.20)	(0.23)	(0.20)	(0.39)	(0.41)	(0.29)	(0.31)	(0.27)
Opp$\times M_{\geq HS}, F_{\geq HS}$	44	-0.71**	-0.86***	-0.08	-0.60***	-0.65***	0.41	0.30	0.29	0.24	0.10
		(0.30)	(0.27)	(0.15)	(0.17)	(0.15)	(0.29)	(0.31)	(0.22)	(0.23)	(0.21)
N				217,431					229,339		

All estimates are multiplied by 100. Standard errors in parentheses, clustered at the year-month of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Main sample with known parental education. Each Panel-Column presents estimates from separate regressions. All models absorb fixed effects for birth municipality, year-month of birth, spacing in months to younger sibling, second generation immigrant status, maternal age at birth, paternal age at birth, maternal level-field of education, paternal level-field of education, and age at last educational observation. $M_{<HS}$ ($F_{<HS}$) indicates that the mother (father) has less than 12 years of education.

Table 9

STEM Education: Heterogeneity by Parental Field

	Women					**Men**				
	Any STEM		Drop-	STEM Tert		Any STEM		Drop-	STEM Tert	
	Enr	Com	out	Enr	Com	Enr	Com	out	Enr	Com
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Opposite Sex Sib	-0.10	-0.48	0.09	-0.57*	-0.43*	-0.63	-0.62	0.16	0.24	0.11
	(0.52)	(0.47)	(0.26)	(0.30)	(0.26)	(0.52)	(0.54)	(0.39)	(0.41)	(0.36)
Opp × Mom STEM	0.16	-0.08	0.74**	0.01	0.07	-0.00	0.27	0.01	0.03	-0.06
	(0.70)	(0.63)	(0.35)	(0.40)	(0.35)	(0.69)	(0.72)	(0.52)	(0.55)	(0.48)
Opp × Mom Care	-0.42	-0.04	-0.21	-0.10	-0.19	-0.21	-0.03	-0.55	-0.07	-0.16
	(0.53)	(0.47)	(0.27)	(0.31)	(0.26)	(0.52)	(0.55)	(0.39)	(0.42)	(0.37)
Opp × Mom Adm	-1.38***	-1.14**	-0.01	-0.35	-0.50**	0.31	0.31	-0.50	0.21	-0.01
	(0.51)	(0.46)	(0.26)	(0.30)	(0.25)	(0.50)	(0.53)	(0.38)	(0.40)	(0.35)
Opp × Dad STEM	0.22	0.42	-0.21	0.27	0.19	1.17**	1.07**	0.59	0.03	0.00
	(0.52)	(0.46)	(0.26)	(0.30)	(0.26)	(0.51)	(0.54)	(0.38)	(0.41)	(0.36)
Opp × Dad Care	-0.15	-0.59	0.20	0.29	0.24	-0.52	-0.45	0.18	-1.29**	-0.83
	(0.82)	(0.73)	(0.41)	(0.47)	(0.40)	(0.81)	(0.85)	(0.61)	(0.64)	(0.57)
Opp × Dad Adm	0.07	0.25	-0.16	0.38	0.14	2.06***	1.27**	1.11**	0.57	0.35
	(0.62)	(0.55)	(0.31)	(0.36)	(0.31)	(0.61)	(0.64)	(0.46)	(0.49)	(0.43)
N			228,856					240,902		

All estimates are multiplied by 100. Standard errors in parentheses, clustered at the year-month of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Main sample. Each Panel-Column presents estimates from separate regressions. All models absorb fixed effects for birth municipality, year-month of birth, spacing in months to younger sibling, second generation immigrant status, maternal age at birth, paternal age at birth, maternal level-field of education, paternal level-field of education, and age at last educational observation.

5.3 Family Structure at Age 17

Table 10
Family Structure at Age 17

	Women			Men		
Sample	All	Non-Traditional		All	Non-Traditional	
Firstborn lives w	Both parents (1)	SSP (2)	SSP, sib w OSP (3)	Both parents (4)	SSP (5)	SSP, sib w OSP (6)
Opposite Sex Sib	-0.02	1.02***	5.05***	-0.09	0.67	3.44***
	(0.17)	(0.37)	(0.24)	(0.16)	(0.41)	(0.34)
Same Sex Mean	78.5	78.4	4.5	79.0	29.0	14.3
Pct. Δ rel. to SS	0.0	1.3	113.5	-0.1	2.3	24.1
N	207,231	44,652	44,435	218,574	45,916	45,689

All estimates are multiplied by 100. Standard errors in parentheses, clustered at the year-month of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Main sample, born 1962–1988. Each Panel-Column presents estimates from separate regressions. All models absorb fixed effects for birth municipality, year-month of birth, spacing in months to younger sibling, second generation immigrant status, maternal age at birth, paternal age at birth, maternal level-field of education, paternal level-field of education, and age at last educational observation. *SSP* indicates that the firstborn child lives with its same sex parent. *SSP, sib x OSP* indicates that the firstborn child lives with its same sex parent and the second child lives with the opposite sex parent (opposite sex compared to the first child's gender). *Non-traditional* refers the the sample of children who do not live with both biological parents at age 17.

In the extreme case of parental divorce or separation (henceforth *divorce*), the living arrangement between parents and children might additionally help shed light on child-parent interactions. If parents of mixed sex children gender-specialize more than parents of same sex children, children with an opposite sex sibling might be more likely to live with their same sex parent (*SSP*) in case of parental divorce. Moreover, a family living arrangement where the oldest child lives with the same sex parent and the younger child lives with the opposite sex parent (*OSP*) might be more prevalent. Yet, sibling gender composition might also affect the likelihood of living in a traditional family, defined as living with both biological parents. Table 10 studies how sibling gender composition affects family structure at age 17 for the main sample, though restricted to birth cohorts born between 1962 and 1988.[25] From this, it is clear that sibling gender composition does not alter the probability to live in a traditional family

[25]This restriction is due to data availability. The first time I observe with whom the child lives is in 1980. I observe the family structure on January 1^{st} each year and use the observation for the year the person turns 18 years or the last year in which the child lives with at least one biological parent.

by age 17, neither for women nor for men [Columns (1) and (4), respectively].

Conditional on living in a non-traditional family, the results show a pattern consistent with the predictions. Women with an opposite sex sibling are more likely to live with their mother [Column (2)]. Furthermore, both men and women with an opposite sex sibling are more likely to live in a living arrangement in which they live with their same sex parent and their younger sibling lives with the opposite sex parent [Columns (3) and (6)]. For women (men) the estimated effect is 5.1 (3.4) percentage points, corresponding to an increase of 114 (24) percent relative to the mean for women (men) with a same sex sibling. These results consequently show a strong effect on the living arrangement among non-traditional families. The pattern is closely in line with more gender-specific parenting in families with mixed sex children.

5.4 Parental Quality Time

To further investigate whether sibling gender composition affects child-parent interactions —and in particular, whether it affects parents' quality time investment—I draw on the Danish Longitudinal Survey of Children (DALSC). This is a unique survey due to its very detailed information on family socio-economic characteristics, family structure, and parental time use. The sample consists of 6,011 randomly sampled children born between September 15 and October 31, 1995 to a mother with Danish citizenship and consists of five waves (1996, 1999, 2003, 2007, and 2011). For this analysis, I select firstborn children who have at least one younger sibling born within seven calendar years apart.[26] I construct a parental quality time index measuring the number of times a week each parent does a particular quality time activity with the child. At age 7 and 11, both parents report how often they do different types of activities together with their child. I define quality time as playing with the child, helping with homework, doing out-of-school activities, reading/singing, and going on a trip.[27]

Columns (1) to (4) in Table 11 provide the results on parental quality time investment by each parent for the two ages, separately. Mothers to girls with an opposite sex sibling invest more quality time in their daughter at both ages compared to mothers with two daughters. On average, mothers spend 0.6 activities more each week, corresponding to an increase of five and nine percent at respectively age 7 and 11. In contrast, fathers spend 11–15 percent less time with their firstborn daughter when having mixed sex children. This reduction in total paternal quality time is driven by decreased time spent on help with homework and reading for the daughter [Appendix

[26]I only observe the year of birth of siblings and do therefore not have more precise information on the spacing.

[27]Parents report how often they do these activities with the child; I code "almost dayly" as 6 times a week, "2–3 times a week" as 2.5, "sometimes" as 0.5, and "never" as 0.

Table A6]. This finding might suggest that girls with an opposite sex sibling receive less qualified help with STEM-related homework, which might prevent them from growing interests for the field. Overall, girls receive the same amount of quality time no matter the gender of their younger sibling. However, these results clearly show that girls with an opposite sex sibling experience more gendered parenting.

Table 11
Parental Quality Time and Housework at Age 7 and 11

	Parental Quality Time				Housework w Parents	
	Age 7		Age 11		Age 7	Age 11
	Mom	Dad	Mom	Dad		
	(1)	(2)	(3)	(4)	(5)	(6)
Girls						
Opposite Sex Sib	0.60*	-0.98**	0.59*	-0.83**	0.00	-0.25
	(0.36)	(0.44)	(0.35)	(0.35)	(0.29)	(0.28)
Same Sex Mean	12.74	8.98	6.57	5.69	3.82	3.81
Pct. Δ rel. to SS	4.7	-10.9	9.0	-14.6	0.0	-6.6
N	732	520	670	454	514	435
Boys						
Opposite Sex Sib	-0.78**	-0.26	-0.67**	0.01	-0.58**	-0.13
	(0.38)	(0.42)	(0.34)	(0.39)	(0.27)	(0.28)
Same Sex Mean	12.66	9.35	7.49	5.86	3.73	3.08
Pct. Δ rel. to SS	-6.2	-2.8	-8.9	0.2	-15.6	-4.2
N	759	566	687	462	562	438

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. DALSC sample. Each Panel-Column represents the results from separate regressions. All models control for mother's and father's age (squared) and fixed effects for spacing to the younger sibling in years, parental marital status in 1996, parents having been together for at least 5 years in 1996, region of birth, maternal level of education, paternal level of education, family income level in 1995, mother's preferred gender of child, and father's preferred gender of child. *Parental quality time* is measured as the total number of activities (playing, doing homework, doing out-of-school activities, reading/singing, going on a trip) done together with the child at a weekly basis. *Housework with parents* measures the total number of housework activities (cooking, domestic chores) done together with the child at a weekly basis.

For boys, the overall picture is similar. Mothers invest less time in their son when having mixed sex children; the magnitude of the effect is comparable to the effect for girls. This reduction in mother's time with sons is mainly driven by a decrease in time spent playing and, to some extent, reading with the son. In contrast, sibling gender composition does not affect father's total quality time with boys. This, however, masks some important findings when considering the individual components of the index: Fathers play less with their son but are more likely to do homework and to read often to the son at age 7 when having mixed sex children. Consequently, boys receive, on average, less total parental quality time. This could help explain the finding that men with an opposite sex sibling tend to move from academic high school to STEM vocational secondary education. Despite an overall decrease in parental quality time spent with sons, the findings still demonstrate that boys with an opposite sex sibling receive proportionally more male inputs. In conclusion, this analysis supports that gender-specific parenting might be an important mechanism for the results on STEM preferences.

5.5 Exposure to Gender-Stereotypical Activities

As a final investigation of mechanisms, I consider whether boys and girls are differentially affected by having a sibling of the opposite gender in terms of exposure to female-typed activities. With data from the DALSC, I construct an index measuring the total number of times a week the parents involve the child in housework activities (cooking and other domestic chores reported by each parent). Sibling gender does not affect girls' involvement in housework with parents [Table 11, Columns (5) and (6)]. In contrast, at age 7, boys with an opposite sex sibling are 16 percent less involved in houwesork activities. This difference in housework involvement has, however, faded out by age 11. Thus, these results suggest that boys at young ages are more exposed to gender-stereotypical behavior when having a sibling of the opposite gender.[28] This, in turn, might partly explain the changes in STEM preferences among men.

6 Robustness Checks

6.1 Parental SES Response to Gender Composition of Children

Besides the differences in child-parent interactions, a relevant question is whether parents respond to the gender composition of their children in terms of socio-economic characteristics. Graphs (a) and (b) in Appendix Figure A3 show that the gender of the second child does not affect birth spacing between the first- and second-born child for cohorts born between 1985 and 2002 and for the main sample (born between 1960

[28] An alternative interpretation is that boys exhibit more gender-stereotypical behavior. However, I cannot test for this distinction.

and 1988), respectively. Although shown in the same graph, the estimates come from separate regressions by the gender of the first child. Meanwhile, having two mixed sex children reduces the probability of getting a third child, especially between three and eight years after the birth of the first child [Graphs (c) and (d)]. For the main sample, this effect corresponds to a 4.4 percentage points (13 percent) reduction in the probability of having at least two siblings for women and 6.2 percentage points (18 percent) for men [Appendix Table A1, Columns (2) and (3)]. Thus, firstborn men and women with a younger sibling of the opposite gender come, on average, from slightly smaller families.

The graphs in Appendix Figure A4 illustrate the estimates from an event study of the effect of having a second child of the opposite sex on a variety of parental SES characteristics. Again this is estimated separately by the gender of the first child, although shown in the same graph, from five years before the first child's birth through 16 years after for cohorts born between 1985 and 2002. The gender composition of children does not affect parental cohabitation, marital status, or length of education (measured in months). Neither does it affect paternal employment or annual labor earnings. Yet, due to the effect on fertility, mothers with mixed sex children earn around three to five percent more five to nine years after the first child's birth.[29] Meanwhile, they are only significantly more likely to work in one out of the 22 years (9 years after the first child's birth). Thus, the socio-economic conditions experienced during childhood do not, overall, seem to differ by sibling gender composition besides the increased probability of living in a larger family.

6.2 Family Size

Given the relationship between sibling gender composition and family size, a natural question is whether the effect of sibling gender is purely an effect of family size. This subsection tests this by employing three different strategies: 1) to flexibly control for family size, 2) to divide the sample by family size, and 3) to study the effect of having an opposite sex co-twin. Together these robustness analyses provide convincing evidence that family size does not confound the effect of sibling gender composition.

6.2.1 Controls and Subsamples

Controlling for family size may bias the estimates of sibling gender because sibling gender composition affects fertility. Therefore, accounting for family size might lead to a bad control problem. In other words, if the effect of having an opposite sex

[29] The measure of earnings does not include parental leave benefit, implying that the effect on total income is smaller.

sibling goes through family size, the estimate of sibling gender would be attenuated when controlling for family size. Yet, one could also view family size as an omitted variable. In such case the estimate of sibling gender would be upward biased when omitting family size.[30] Thus, both types of biases would imply smaller estimates when controlling for family size. The first row in Appendix Table A7 repeats the main results, while the second row shows the estimates of sibling gender when flexibly accounting for family size.[31] Overall, the estimates are extremely similar; though, the point estimates are, as expected, in most cases slightly smaller when controlling for family size.

Another way to test the robustness of the results is to split the sample by family size.[32] Imagine that those parents with two same sex children who are very gender-stereotypical and have a gender preference for the opposite gender compared to the gender of their first child progress to the third parity. In such case, individuals with a younger same sex sibling who only have one sibling would, on average, come from less gender-stereotypical families compared to the total sample. Therefore, we would expect the effect of having an opposite sex sibling to be larger in magnitude for the one-sibling sample than for the entire sample. Reversely, we would expect individuals with a younger same sex sibling who have at least two younger siblings to come from more gender-stereotypical families, implying that the effect of having an opposite sex sibling would be smaller in magnitude than for the total sample. This is exactly what the results in Appendix Table A7 shows. In fact, the estimates for the sample with at least two siblings are much smaller and insignificant.[33]

6.2.2 Alternative Empirical Strategy: Co-Twin's Gender

To circumvent potential confounding effects from family size, I examine the effect of having a co-twin of the opposite gender as an alternative empirical strategy.[34] The key empirical feature of the sample of twins is that twin gender composition does not affect family size [Column (1)], at least not for the sample of twins born at the first parity.[35] Overall, the effects of having a co-twin of the opposite gender on STEM choice, both for the sample of all twins and twins born at the first parity, are very similar to the main

[30] Accounting for family size would decrease the magnitude of the estimate due to the negative correlation between having an opposite sex sibling and family size.

[31] I flexibly account for family size by including dummies for the number of biological siblings and dummies for the number of children the mother and father potentially have, respectively, from later relationships.

[32] I restrict the sample to individuals who only have biological siblings, i.e. none of their parents have children with another person than the parent; though the results are similar when including those with half-siblings.

[33] However, the insignificance might partly be due to smaller sample sizes.

[34] This approach is similar to the one in Peter et al. (2015) with the caveat that I do not have information on zygocity.

[35] Neither is there a significant effect of the co-twin's gender for women on the probability that parents get an additional child for the sample of twins born at any parity, though the estimate is not a tight zero.

results [Appendix Table A8]. The magnitude of the effects is, however, much larger. Based on the results from this strategy and the two in the previous subsection, family size does not appear to be a confounding factor of the effect of having an opposite sex sibling.

6.3 The Effect of an Older Sibling's Gender

Despite the potential problems with selection bias from estimating the effect of an older sibling's gender, as discussed in Section 2, we would still expect the direction of the effect on STEM education to be the same. Such analysis can thus serve as a robustness check. Considering the potential bias, if parents who prefer a son want their son to be more gender-stereotypical than the average, the effect of having an older sister on the sample of second-born sons would be upward biased, according to the example on parental gender preferences. Appendix Table A9 shows the results from an analysis of the association between having an older opposite sex sibling for a sample of second-born children. Overall, these results are similar to the main results on STEM education. However, for men, the effects on any STEM enrollment and completion are three to four times larger than for the main results, which might both be due to selection bias and due to a role-model effect of the older sibling.

6.4 Alternative Measures of Field of Study

As a final test of the robustness of the main findings, I consider five alternative measures of field of study. First, I restrict the STEM program to be a university program (*STEM Ac Tert*) and not just at the tertiary level. Second, I restrict STEM at the tertiary level to only include high earnings programs (*High Earnings STEM*).[36] Third, rather than focusing on STEM, I consider high earnings majors more broadly (*High Earnings Broad*).[37] Fourth, I define the Care field as a typical female field at any level; this definition includes the fields Education, Health, and Welfare. Fifth, I restrict the Care field to be at the tertiary level. Appendix Table A10 shows that the results for these alternative measures are very similar to the main findings. Thus, the main results are not sensitive to the definition of STEM or focusing more broadly on high earnings majors. Moreover, the results on choosing an education within Care stress the main finding that having an opposite sex sibling makes both men and women's choice more

[36] These exclude natural sciences.

[37] This group of majors are programs at the tertiary level and within the fields: Economics, Political Science, Law, Mathematics, Statistics, Information Communication Technologies, Engineering, Mining and Extraction, and Medicine. These fields are selected on the requirement that, in the main sample, people within their field of study earn, on average, at least 500,000 DKK 2015-prices at age 35 and at least 600,000 DKK at age 40.

gender-stereotypical.

7 Conclusion

The family shapes men and women's preferences for the traditionally male-dominated STEM field. This study shows that having an opposite sex sibling increases the probability to choose a gender-stereotypical field of education. Women already opt out of STEM at the time of their first active educational choice at the end of 9^{th} grade. Men, on the contrary, show an increased interest for the STEM field but are not more likely to succeed in high-level STEM programs. An important mechanism for these findings is the effect on child-parent interactions. Parents with mixed sex children gender-specialize their parenting more and spend more quality time with their same sex child than parents with same sex children. Moreover, I show that young boys with an opposite sex sibling are exposed to more gender-stereotypical behavior within the family than boys with a same sex sibling.

My findings emphasize that if policy makers want to increase the number of people —and particularly women—within the STEM field, they need to focus on early educational choices made already at the end of compulsory schooling. However, attention to decisions at this educational stage is not sufficient. As my analysis of mechanisms stresses, the family —representing a central aspect of the social environment —influences the formation of STEM preferences throughout childhood. Moreover, no evidence shows that men possess an inherent advantage over women in math ability: boys and girls start school with similar math performance; yet, around the time of puberty, the gender difference in average math performance (favoring boys) stabilizes Kahn and Ginther (2017). This suggests that social environmental factors influence how boys and girls develop interests and abilities within the STEM field already during early school grades. Consequently, if we want to give boys and girls the same opportunities in terms of labor market performance in adulthood, policies would need to focus on how to counteract the transmission of gender norms across generations and thereby the development of gender-stereotypical behaviors, attitudes, and preferences.

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A Appendix

A.1 Alternative Mechanisms

This appendix describes alternative mechanisms to the ones discussed in Subsection 5.1. These mechanisms are, however, not compatible with the empirical findings.

The effect of sibling interactions might also go in the opposite direction for two reasons. First, the spillover model in developmental psychology hypothesizes that siblings imitate and influence each other with their gender-specific traits. For instance, Brim (1958) and Koch (1955) show that mixed sex siblings exhibit more traits of the opposite gender and fewer of their own gender compared to same sex sibling pairs. Second, the reference group theory in sociology suggests that as soon as a same sex sibling is present in the family, the same sex sibling will be the child and parents' reference group (Butcher and Case, 1994). Therefore, having a same sex sibling might induce the child to behave more gender-stereotypically. Meanwhile, given the empirical findings, neither of these two theories can be the dominating mechanism for the effect of sibling gender composition on the development of STEM preferences.

Studies examining the relationship between sibling gender composition and educational attainment have argued that budget constraints may play an important role (Amin, 2009; Butcher and Case, 1994). If parents face no borrowing constraints, they should, according to standard economic theory, invest in each child until marginal costs equal marginal benefits. However, if parents face borrowing constraints, they might decide to allocate their financial resources depending on the gender composition of their children. If parents want income equality between their children and the returns to education are smaller for women than men, then having a brother instead of a sister would be beneficial. However, parental aversion to income inequality cannot be the dominating channel, as we would otherwise have observed that having a sibling of the opposite gender should make the educational choice less gender-stereotypical. In contrast, parents might want to maximize the total income of their children, thereby investing more in the child with the greatest returns to education. If returns to education are larger for men than women, having a brother would have adverse effects on educational attainment. In support of this argument, Powell and Steelman (1989) find that the number of brothers puts more pressure on parents' financial support than do the number of sisters for individuals enrolled in college in the U.S.

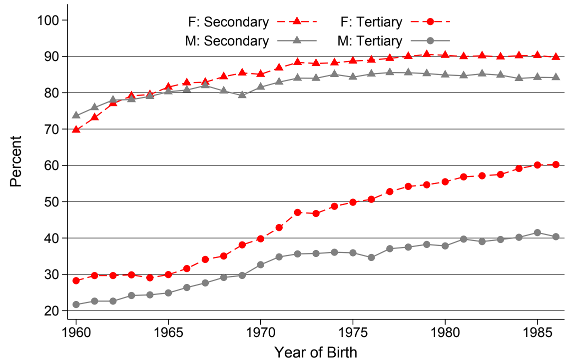
Nevertheless, this is not a likely mechanism in the Danish context because there is no tuition fee at any educational level and because students in tertiary education receive governmental student grants and loans to cover living expenses. For all cohorts in the analysis, students in tertiary education have at least had access to a combination of grants and loans of 1,000 USD a month in 2017-prices. Moreover, it is less clear how borrowing constraints should affect field choice, given sibling gender composition has no effect on the probability of any enrollment after compulsory education.

Another possible explanation might be that parents want at least one child within a high-paying STEM occupation. This is, however, not a likely mechanisms, because we would then have expected men with an opposite sex sibling to be more likely to go into tertiary STEM education rather than vocational STEM education at the secondary level.

A.2 Appendix Figures and Tables

Figure A1

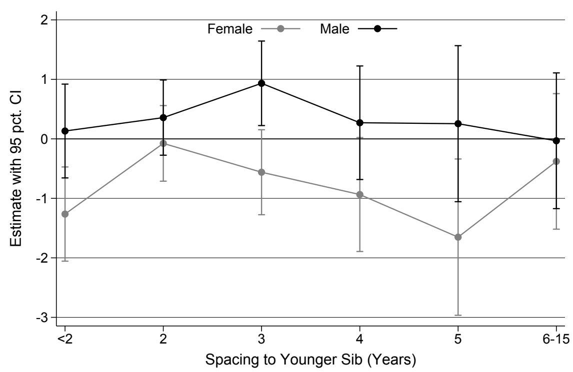
Educational Attainment at Age 30 by Gender Across Cohorts



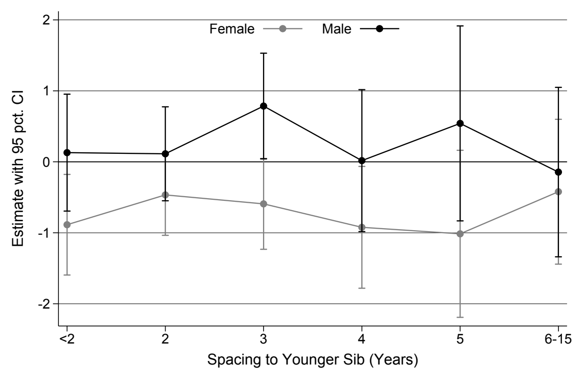
Note: Main sample. The graph illustrates the share of a cohort completing at least secondary and at least tertiary education, respectively. *F* in the labels refers to *female* and *M* to *male*.

Figure A2

Any STEM Enrollment and Completion by Spacing



(a) Any STEM Enr

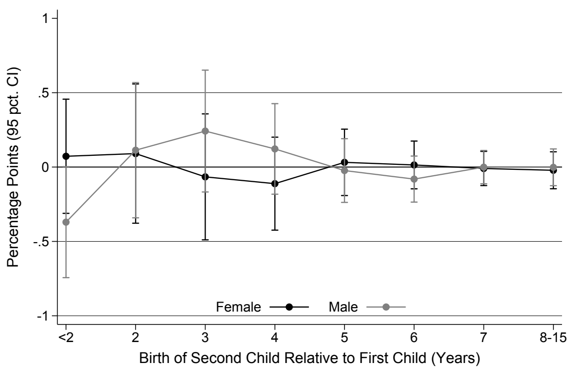


(b) Any STEM Compl

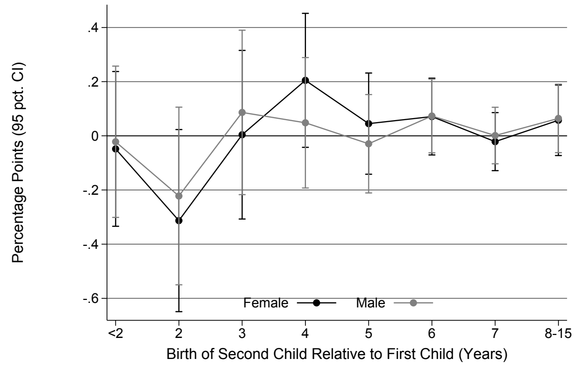
Note: Main sample. Both graphs illustrate the estimated effect of having an opposite sex sibling by birth spacing; the estimates come from separate regressions by gender. The whiskers represent the 95 percent confidence interval. The estimates for women are also displayed in Columns (1) and (2) in Appendix Table A2, while the ones for men are found in Columns (6) and (7).

Figure A3

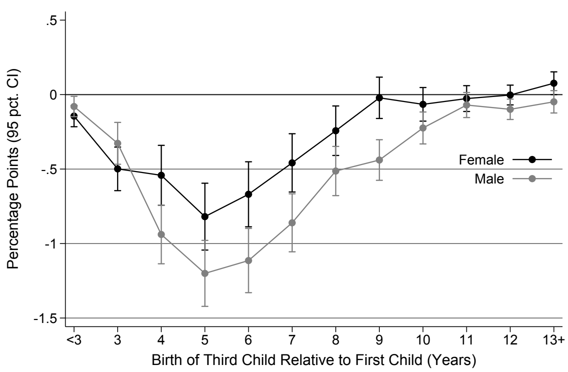
Fertility and Spacing



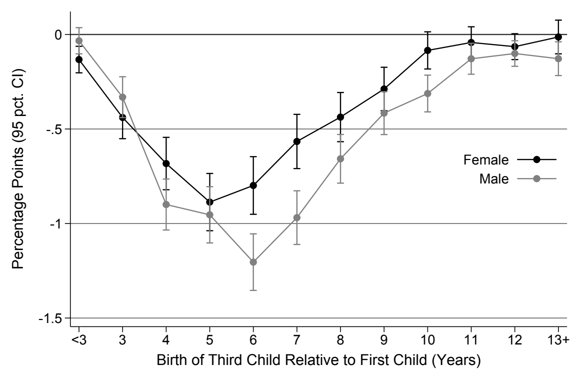
(a) Spacing (1985–2002)



(b) Spacing (1960–1988)



(c) Third Child (1985–2002)

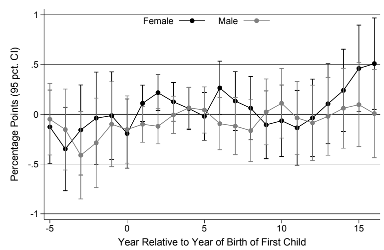


(d) Third Child (1960–1988)

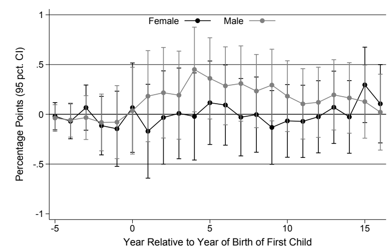
Note: Graphs (a) and (c) uses a sample of children born between 1985 and 2002 with same restrictions as the main sample. Graphs (b) and (d) use the main sample. The whiskers represent the 95 percent confidence interval. All graphs illustrate the estimates from an event study of the effect of having a second child of the opposite sex by gender of the first child.

Figure A4

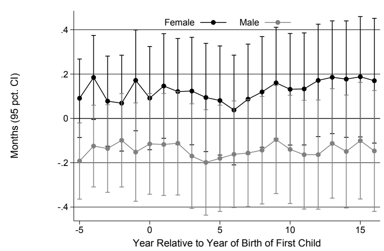
Family Structure and Parental Education, Employment, and Earnings



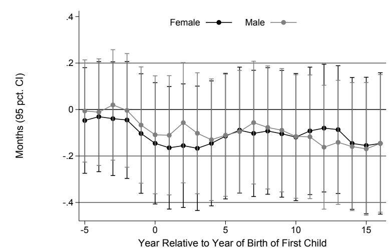
(a) Parents Cohabit



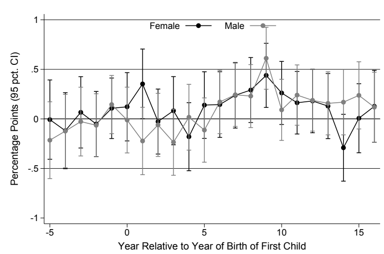
(b) Parents are Married



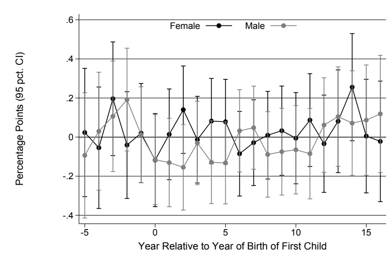
(c) Mother's Edu (months)



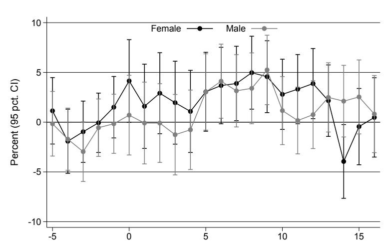
(d) Father's Edu (months)



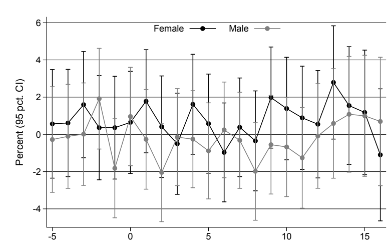
(e) Mother Employed



(f) Father Employed



(g) Mother's Log(earnings)



(h) Father's Log(earnings)

Note: Sample of children born between 1985 and 2002 with same restrictions as the main sample. The whiskers represent the 95 percent confidence interval. All graphs illustrate the estimates from an event study of the effect of having a second child of the opposite sex by gender of the first child.

Table A1

Gender Composition of Current Children and Subsequent Fertility

Gender Composition		Girl	Boy	GG	GB	BG	BB
Parents get child #	2	3		4			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Having at lest one more child							
1^{st} is Boy	0.06						
	(0.09)						
2^{nd} child is Boy		-4.37***	6.17***				
		(0.16)	(0.16)				
3^{rd} child is Boy				-4.21***	-0.08	-0.09	4.78***
				(0.35)	(0.37)	(0.37)	(0.33)
N	791,893	281,484	296,653	45,433	41,548	41,330	52,886
Mean (pct.)	73.7	31.2	32.0	20.7	20.1	19.9	19.7
Panel B: Spacing in months to next child							
1^{st} is Boy	-0.10						
	(0.06)						
2^{nd} is Boy		2.29***	-1.64***				
		(0.21)	(0.20)				
3^{rd} child is Boy				2.23***	2.05***	-0.02	-0.82
				(0.69)	(0.74)	(0.73)	(0.65)
N	584,289	88,037	95,376	9,426	8,371	8,244	10,443
Mean (months)	41.5	53.4	53.8	49.6	49.1	49.3	50.0

All estimates in Panel A are multiplied by 100. Standard errors in parentheses, clustered at the year-month of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Each Panel-Column presents estimates from separate regressions. The sample consists of couples who get their first child (excluding twin births and children not surviving one year) between 1960 and 1988 and who do not have children from previous relationships. The samples in Columns (2) and (3) consist of couples with respectively a firstborn girl and boy; the sample in Column (4) consists of couples with a firstborn girl and second-born girl and similarly for the remaining columns. The sample in Panel B is conditional on getting a subsequent child relative to the parity. All models absorb fixed effects for the first child's birth municipality, year-month of birth, second generation immigrant status, maternal age at birth, paternal age at birth, maternal level-field of education,and paternal level-field of education. Models (2)–(7) in Panel A also include spacing dummies (in months) to younger sibling(s).

Table A2

STEM Education: Heterogeneity by Spacing

	Women					Men				
	Any STEM		Drop-	STEM Tertiary		Any STEM		Drop-	STEM Tertiary	
	Enr	Com	out	Enr	Com	Enr	Com	out	Enr	Com
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Opp × <2 years	-1.15***	-0.89**	-0.19	-0.26	-0.35*	0.03	0.12	0.37	0.80**	0.50*
	(0.40)	(0.36)	(0.20)	(0.23)	(0.20)	(0.40)	(0.42)	(0.30)	(0.32)	(0.28)
Opp ×2 years	-0.07	-0.47	0.16	-0.60***	-0.59***	0.35	0.11	0.59**	0.32	0.04
	(0.33)	(0.29)	(0.16)	(0.19)	(0.16)	(0.32)	(0.34)	(0.24)	(0.25)	(0.22)
Opp ×3 years	-0.51	-0.59*	-0.10	-0.46**	-0.47***	0.89**	0.80**	0.17	0.32	0.08
	(0.37)	(0.33)	(0.18)	(0.21)	(0.18)	(0.36)	(0.38)	(0.27)	(0.29)	(0.25)
Opp ×4 years	-0.88*	-0.93**	-0.03	-0.56**	-0.53**	0.30	0.01	0.31	-0.41	-0.63*
	(0.49)	(0.44)	(0.25)	(0.28)	(0.24)	(0.48)	(0.51)	(0.36)	(0.38)	(0.34)
Opp ×5 years	-1.52**	-1.02*	-0.72**	-0.73*	-0.43	0.25	0.54	-0.68	0.20	0.28
	(0.67)	(0.60)	(0.34)	(0.39)	(0.33)	(0.66)	(0.70)	(0.50)	(0.53)	(0.46)
Opp ×6–15 years	-0.33	-0.42	0.07	0.17	-0.08	0.07	-0.14	0.20	-0.39	-0.54
	(0.58)	(0.52)	(0.29)	(0.34)	(0.29)	(0.58)	(0.61)	(0.44)	(0.46)	(0.40)
N			272,400					286,207		

All estimates are multiplied by 100. Standard errors in parentheses, clustered at the year-month of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Main sample. Each Panel-Column presents estimates from separate regressions. All models absorb fixed effects for birth municipality, year-month of birth, spacing in months to younger sibling, second generation immigrant status, maternal age at birth, paternal age at birth, maternal level-field of education, paternal level-field of education, and age at last educational observation.

Table A3

STEM Education: Heterogeneity by Decade of Birth

	Women					Men				
	Any STEM		Drop-	STEM Tertiary		Any STEM		Drop-	STEM Tertiary	
	Enr	Com	out	Enr	Com	Enr	Com	out	Enr	Com
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Opposite Sex Sib	-0.77***	-0.72***	-0.19	-0.48***	-0.40***	0.23	0.34	0.18	0.25	-0.01
	(0.30)	(0.26)	(0.15)	(0.17)	(0.15)	(0.29)	(0.31)	(0.22)	(0.23)	(0.20)
Opp$\times$1970 $-$ 79	0.12	-0.02	0.20	-0.13	-0.29	0.42	-0.19	0.48	0.14	0.12
	(0.44)	(0.40)	(0.22)	(0.26)	(0.22)	(0.44)	(0.46)	(0.33)	(0.35)	(0.31)
Opp$\times$1980 $-$ 88	0.70	0.22	0.40	0.19	0.00	0.16	0.08	0.16	0.12	0.12
	(0.49)	(0.44)	(0.25)	(0.28)	(0.24)	(0.48)	(0.51)	(0.36)	(0.38)	(0.34)
Prob>F1	0.344	0.844	0.252	0.548	0.361	0.634	0.857	0.339	0.915	0.905
N			228,856					240,902		

All estimates are multiplied by 100. Standard errors in parentheses, clustered at the year-month of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Main sample. Each Panel-Column presents estimates from separate regressions. All models absorb fixed effects for birth municipality, year-month of birth, spacing in months to younger sibling, second generation immigrant status, maternal age at birth, paternal age at birth, maternal level-field of education, paternal level-field of education, and age at last educational observation. *Prob>F1* reports the p-value from an F-test of joint significance of opposite sex sibling interactions with decade of birth.

Table A4

STEM Education: Heterogeneity by Type of Parental Education

		Women					**Men**				
		Any STEM		Drop-	STEM Tertiary		Any STEM		Drop-	STEM Tertiary	
		Enr	Com	out	Enr	Com	Enr	Com	out	Enr	Com
	Pct.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Opp$\times M_{Low}, F_{Low}$	0.21	0.73*	0.15	0.50**	0.04	0.08	-0.22	-0.02	0.01	0.02	-0.06
		(0.43)	(0.38)	(0.21)	(0.25)	(0.21)	(0.42)	(0.44)	(0.31)	(0.33)	(0.30)
Opp$\times M_{Low}, F_{Voc}$	0.21	-0.54	-0.54	0.04	-0.26	-0.39*	1.07**	0.75*	0.75**	0.72**	0.30
		(0.43)	(0.39)	(0.21)	(0.25)	(0.21)	(0.43)	(0.45)	(0.32)	(0.34)	(0.30)
Opp$\times M_{Low}, F_{Ac}$	0.02	-2.64**	-1.63	-1.86***	-1.27*	-0.75	0.73	0.04	0.28	-0.34	-0.53
		(1.30)	(1.16)	(0.64)	(0.75)	(0.64)	(1.30)	(1.37)	(0.97)	(1.04)	(0.92)
Opp$\times M_{Voc}, F_{Low}$	0.08	-1.35*	-1.95***	0.19	-0.81**	-1.01***	-0.02	0.45	0.18	0.84	0.18
		(0.70)	(0.63)	(0.35)	(0.41)	(0.35)	(0.70)	(0.73)	(0.52)	(0.56)	(0.49)
Opp$\times M_{Voc}, F_{Voc}$	0.25	-1.17***	-1.19***	-0.19	-0.75***	-0.80***	1.00***	0.58	0.63**	0.36	0.24
		(0.40)	(0.35)	(0.20)	(0.23)	(0.20)	(0.38)	(0.41)	(0.29)	(0.31)	(0.27)
Opp$\times M_{Voc}, F_{Ac}$	0.06	0.04	-0.18	0.66*	-0.31	0.00	0.77	0.69	-0.37	0.69	0.90*
		(0.78)	(0.70)	(0.39)	(0.45)	(0.39)	(0.77)	(0.82)	(0.58)	(0.62)	(0.55)
Opp$\times M_{Ac}, F_{Low}$	0.02	-2.59*	-0.88	-0.80	-1.09	-1.13	0.64	0.18	1.92*	1.97*	0.04
		(1.43)	(1.29)	(0.71)	(0.83)	(0.71)	(1.41)	(1.49)	(1.06)	(1.13)	(1.00)
Opp$\times M_{Ac}, F_{Voc}$	0.06	-0.22	-0.34	-0.77**	-0.54	-0.64	-0.62	-0.60	0.02	0.15	-0.21
		(0.79)	(0.71)	(0.39)	(0.46)	(0.39)	(0.78)	(0.82)	(0.58)	(0.62)	(0.55)
Opp$\times M_{Ac}, F_{Ac}$	0.09	-0.24	-0.46	0.12	-0.54	-0.61*	-0.30	0.06	0.15	-0.37	-0.51
		(0.67)	(0.60)	(0.33)	(0.39)	(0.33)	(0.66)	(0.69)	(0.49)	(0.53)	(0.47)
N				217,431					229,339		

All estimates are multiplied by 100. Standard errors in parentheses, clustered at the year-month of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Main sample with known parental education. Each Panel-Column presents estimates from separate regressions. All models absorb fixed effects for birth municipality, year-month of birth, spacing in months to younger sibling, second generation immigrant status, maternal age at birth, paternal age at birth, maternal level-field of education, paternal level-field of education, and age at last educational observation. *Ac* parental education refers to academic or professional education at the secondary or tertiary level, *Voc* refers to vocational education, and *Low* refers to lower education (typically nine or fewer years or schooling).

Table A5

Components of Maternal Quality Time at Age 7 and 11

	Play		Homework		Read	
	Times a week (1)	Often (2)	Times a week (3)	Often (4)	Times a week (5)	Often (6)
Panel A: Girls						
			Age 7 ($N = 732$)			
Opposite Sex Sib	0.16	1.29	0.19	4.98	0.08	2.09
	(0.16)	(3.17)	(0.17)	(3.60)	(0.16)	(3.68)
Same Sex Mean	2.54	22.89	4.03	55.79	4.28	59.74
Pct. Δ rel. to SS	6.3	5.6	4.7	8.9	1.9	3.5
			Age 11 ($N = 670$)			
Opposite Sex Sib	0.11	3.46	0.29	5.71	0.14	4.69
	(0.11)	(3.72)	(0.18)	(3.65)	(0.13)	(3.09)
Same Sex Mean	1.17	31.61	2.90	67.82	0.77	16.67
Pct. Δ rel. to SS	9.4	10.9	10.0	8.4	18.3	28.1
Panel B: Boys						
			Age 7 ($N = 759$)			
Opposite Sex Sib	-0.28*	-5.86*	-0.13	-1.84	-0.26	-5.55
	(0.16)	(3.22)	(0.19)	(3.68)	(0.16)	(3.62)
Same Sex Mean	2.86	27.97	3.47	47.49	4.39	61.48
Pct. Δ rel. to SS	-9.8	-21.0	-3.7	-3.9	-5.9	-9.0
			Age 11 ($N = 687$)			
Opposite Sex Sib	-0.30***	-9.71***	0.01	3.43	-0.24*	-4.27
	(0.11)	(3.62)	(0.18)	(3.37)	(0.14)	(3.21)
Same Sex Mean	1.30	36.09	3.49	73.96	1.07	23.67
Pct. Δ rel. to SS	-23.0	-26.9	0.3	4.6	-22.5	-18.0

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. DALSC sample. Each Panel-Column represents the results from separate regressions. All models control for mother's and father's age (squared) and fixed effects for spacing to the younger sibling in years, parental marital status in 1996, parents having been together for at least 5 years in 1996, region of birth, maternal level of education, paternal level of education, family income level in 1995, mother's preferred gender of child, and father's preferred gender of child. Each of the three individual components of parental quality time is measured as the total number of activities done together with the child at a weekly basis and as an indicator for doing the particular activity often. *Often* refers to *almost daily* at age 7 and *at least 2-3 times a week* at age 11.

Table A6

Components of Paternal Quality Time at Age 7 and 11

	Play		Homework		Read	
	Times a week	Often	Times a week	Often	Times a week	Often
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Girls						
	Age 7 ($N = 520$)					
Opposite Sex Sib	-0.04	0.18	-0.35**	-6.25**	-0.54***	-13.23***
	(0.20)	(4.22)	(0.16)	(2.79)	(0.18)	(4.33)
Same Sex Mean	3.00	29.32	1.89	13.53	2.52	63.91
Pct. Δ rel. to SS	-1.3	0.6	-18.5	-46.2	-21.4	-20.7
	Age 11 ($N = 454$)					
Opposite Sex Sib	-0.20	-5.99	-0.39**	-10.81**	-0.09	-3.10
	(0.14)	(4.68)	(0.16)	(4.72)	(0.10)	(2.98)
Same Sex Mean	1.51	41.67	1.89	54.58	0.59	12.50
Pct. Δ rel. to SS	-13.2	-14.4	-20.7	-19.8	-15.2	-24.8
Panel B: Boys						
	Age 7 ($N = 566$)					
Opposite Sex Sib	-0.44**	-10.06**	0.15	4.32*	0.22	7.26*
	(0.18)	(4.03)	(0.16)	(2.62)	(0.17)	(3.96)
Same Sex Mean	3.43	36.99	1.54	8.56	2.33	55.48
Pct. Δ rel. to SS	-12.8	-27.2	9.7	50.5	9.4	13.1
	Age 11 ($N = 462$)					
Opposite Sex Sib	0.06	2.20	0.07	-1.05	0.18	3.43
	(0.15)	(4.81)	(0.18)	(4.86)	(0.12)	(3.45)
Same Sex Mean	1.47	41.20	1.61	43.78	0.57	13.30
Pct. Δ rel. to SS	4.1	5.3	4.4	-2.4	31.4	25.8

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. DALSC sample. Each Panel-Column represents the results from separate regressions. All models control for mother's and father's age (squared) and fixed effects for spacing to the younger sibling in years, parental marital status in 1996, parents having been together for at least 5 years in 1996, region of birth, maternal level of education, paternal level of education, family income level in 1995, mother's preferred gender of child, and father's preferred gender of child. Each of the three individual components of parental quality time is measured as the total number of activities done together with the child at a weekly basis and as an indicator for doing the particular activity often. *Often* refers to *almost daily* at age 7 (except for *Read* which is measured as for age 11) and *at least 2-3 times a week* at age 11.

Table A7

STEM Education: Controlling for and Splitting by Family Size

	Any		Work	Drop-	Voc Secon		Ac HS		Tert	
	Enr	Compl	Prep	out	Enr	Compl	Enr	Compl	Enr	Compl
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Women										
Main Estimates	-0.56***	-0.67***	-0.35***	-0.02	0.10	0.07	-0.73***	-0.71***	-0.48***	-0.50***
($N = 228,856$)	(0.20)	(0.18)	(0.11)	(0.09)	(0.12)	(0.07)	(0.18)	(0.16)	(0.11)	(0.09)
Family Size Controls	-0.53**	-0.64***	-0.37***	-0.01	0.09	0.06	-0.69***	-0.66***	-0.49***	-0.51***
($N = 228,856$)	(0.20)	(0.18)	(0.11)	(0.09)	(0.12)	(0.07)	(0.18)	(0.16)	(0.11)	(0.09)
1 Sibling	-0.78***	-0.86***	-0.57***	-0.03	0.13	0.09	-0.91***	-0.85***	-0.71***	-0.74***
($N = 133,062$)	(0.25)	(0.23)	(0.15)	(0.12)	(0.14)	(0.10)	(0.23)	(0.21)	(0.15)	(0.12)
2+ Siblings	-0.17	-0.33	-0.09	-0.07	0.03	0.03	-0.41	-0.45	-0.25	-0.21
($N = 73,958$)	(0.34)	(0.31)	(0.19)	(0.17)	(0.20)	(0.13)	(0.32)	(0.29)	(0.18)	(0.15)
Men										
Main Estimates	0.41**	0.29	0.27	0.38***	0.42**	0.35*	0.19	0.03	0.33**	0.06
($N = 240,902$)	(0.20)	(0.20)	(0.20)	(0.13)	(0.19)	(0.18)	(0.20)	(0.16)	(0.14)	(0.13)
Family Size Controls	0.33*	0.20	0.17	0.40***	0.35*	0.26	0.17	0.02	0.31**	0.05
($N = 240,902$)	(0.20)	(0.20)	(0.20)	(0.13)	(0.19)	(0.18)	(0.20)	(0.16)	(0.15)	(0.13)
1 Sibling	0.60**	0.56**	0.44*	0.20	0.48**	0.50**	0.27	0.20	0.33*	0.03
($N = 137,961$)	(0.26)	(0.27)	(0.27)	(0.18)	(0.25)	(0.24)	(0.27)	(0.22)	(0.20)	(0.17)
2+ Siblings	-0.02	-0.11	-0.09	0.46*	0.24	0.04	0.10	-0.12	0.17	0.10
($N = 80,257$)	(0.31)	(0.32)	(0.34)	(0.24)	(0.33)	(0.30)	(0.31)	(0.27)	(0.25)	(0.24)

All estimates are multiplied by 100. Standard errors in parentheses, clustered at the year-month of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Main sample. Each Row-Column presents estimates from separate regressions. All models absorb fixed effects for birth municipality, year-month of birth, spacing in months to younger sibling, second generation immigrant status, maternal age at birth, paternal age at birth, maternal level-field of education, paternal level-field of education, and age at last educational observation. *Family Size Controls*-models further include dummies for the number of biological siblings and dummies for the number of children the mother and father potentially have, respectively, from later relationships. *1 Sibling*-models restrict the sample to those who only have one full sibling and no half-siblings. *2+ Siblings*-models restrict the sample to those who have at least two full siblings and no half-siblings.

Table A8

Effect of Co-Twin's Gender

	Next	Any STEM		STEM Voc Sec		STEM Ac HS		Secondary	
	Birth	Enr	Compl	Enr	Compl	Enr	Compl	Enr	Compl
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Women									
	Any Parity ($N = 15,011$)								
Opp Sex Co-Twin	-0.84	-3.36***	-3.40***	-0.76	-0.34	-2.24***	-2.87***	-0.66	-1.57**
	(0.55)	(0.84)	(0.74)	(0.53)	(0.35)	(0.74)	(0.67)	(0.49)	(0.69)
Same Sex Mean	25.0	32.2	22.2	10.1	4.1	22.7	17.1	92.6	83.0
Pct. Δ rel. to SS	-3.4	-10.5	-15.3	-7.5	-8.3	-9.9	-16.8	-0.7	-1.9
	First Parity ($N = 5,749$)								
Opp Sex Co-Twin	-0.22	-2.42*	-2.56**	0.07	0.61	-1.86	-3.12***	0.06	-1.78
	(0.21)	(1.44)	(1.30)	(0.85)	(0.57)	(1.32)	(1.20)	(0.74)	(1.13)
Same Sex Mean	42.3	33.4	23.7	8.7	3.2	25.1	19.5	93.9	85.1
Pct. Δ rel. to SS	-0.5	-7.2	-10.8	0.8	19.2	-7.4	-16.0	0.1	-2.1
Panel B: Men									
	Any Parity ($N = 15,341$)								
Opp Sex Co-Twin	-1.53***	2.46***	0.66	3.16***	1.70**	-0.11	-1.08	0.67	-0.46
	(0.55)	(0.88)	(0.92)	(0.89)	(0.83)	(0.80)	(0.72)	(0.49)	(0.73)
Same Sex Mean	25.0	63.8	50.1	40.8	29.3	30.1	20.4	92.1	79.9
Pct. Δ rel. to SS	-6.1	3.9	1.3	7.7	5.8	-0.4	-5.3	0.7	-0.6
	First Parity ($N = 5,846$)								
Opp Sex Co-Twin	-0.11	2.87*	-0.30	4.04***	2.34*	0.71	-2.53**	1.09	-0.96
	(0.20)	(1.48)	(1.57)	(1.52)	(1.40)	(1.40)	(1.29)	(0.73)	(1.21)
Same Sex Mean	40.6	64.6	50.9	39.2	27.6	32.4	23.0	93.9	82.1
Pct. Δ rel. to SS	-0.3	4.4	-0.6	10.3	8.5	2.2	-11.0	1.2	-1.2

Standard errors in parentheses, clustered at the mother level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Each Panel-Column-Sample presents estimates from separate regressions. The sample consists of twins born at respectively *any* and *first* parity. All models absorb fixed effects for birth county, year of birth, second generation immigrant status, mother's level and field of education, father's level and field of education, and age at last educational observation. The models further control for (cubed) mother's age at birth and (cubed) father's age at birth. The models for the *Any Parity*-sample further control for parity. *Next Birth* indicates if the parents get a subsequent child.

Table A9

The Effect of an Older Sibling's Gender

	STEM					Edu Attainment				
	Any Enr	Any Compl	Drop-out	Tert Enr	Tert Compl	Length (Mth)	Secon Enr	Secon Compl	Tert Enr	Tert Compl
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Women										
Opposite Sex Sib	-0.59***	-0.51***	-0.02	-0.33***	-0.23***	-0.54***	-0.21*	-0.39***	-0.81***	-0.72***
	(0.20)	(0.17)	(0.10)	(0.10)	(0.08)	(0.11)	(0.11)	(0.15)	(0.19)	(0.19)
Same Sex Mean	30.5	20.3	5.6	6.7	4.7	154.8	90.9	80.9	45.6	38.9
Pct. Δ rel. to SS	-1.9	-2.5	-0.4	-4.9	-4.9	-0.3	-0.2	-0.5	-1.8	-1.9
N						234,926				
Men										
Opposite Sex Sib	1.68***	1.32***	0.52***	0.43***	0.35***	0.23*	0.49***	0.33**	0.35**	0.22
	(0.20)	(0.21)	(0.14)	(0.14)	(0.13)	(0.12)	(0.10)	(0.16)	(0.18)	(0.18)
Same Sex Mean	62.6	48.7	13.2	14.3	10.5	151.4	89.8	77.5	34.6	28.0
Pct. Δ rel. to SS	2.7	2.7	3.9	3.0	3.3	0.2	0.5	0.4	1.0	0.8
N						245,326				

All estimates are multiplied by 100. Standard errors in parentheses, clustered at the year-month of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Sample of second-born children with similar restrictions as main sample. Each Panel-Column presents estimates from separate regressions. All models absorb fixed effects for birth municipality, year-month of birth, spacing in months to older sibling, second generation immigrant status, maternal age at birth, paternal age at birth, maternal level-field of education, paternal level-field of education, and age at last educational observation.

Table A10

Alternative Measures of Field of Study

	STEM Ac Tert		High Earning STEM		High Earning Broad		Any Care		Care Tert	
	Enr	Compl	Enr	Compl	Enr	Compl	Enr	Compl	Enr	Compl
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Women										
Opposite Sex Sib	-0.30***	-0.28***	-0.40***	-0.41***	-0.42***	-0.42***	0.66***	0.65***	0.50***	0.44***
	(0.09)	(0.07)	(0.09)	(0.08)	(0.12)	(0.10)	(0.19)	(0.18)	(0.18)	(0.17)
Same Sex Mean	4.3	3.5	5.6	4.1	9.0	6.3	32.5	26.4	25.9	21.3
Pct. Δ rel. to SS	-7.0	-8.1	-7.1	-10.0	-4.6	-6.6	2.0	2.5	1.9	2.1
N	228,856									
Men										
Opposite Sex Sib	0.17	0.04	0.34**	0.08	0.10	-0.12	-0.31***	-0.25***	-0.31***	-0.25***
	(0.11)	(0.09)	(0.14)	(0.12)	(0.14)	(0.13)	(0.10)	(0.08)	(0.10)	(0.08)
Same Sex Mean	9.4	5.5	15.2	11.5	16.7	11.7	7.0	4.7	6.4	4.4
Pct. Δ rel. to SS	1.8	0.7	2.2	0.7	0.6	-1.0	-4.4	-5.3	-4.9	-5.7
N	240,902									

All estimates are multiplied by 100. Standard errors in parentheses, clustered at the year-month of birth level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Main sample. Each Panel-Column presents estimates from separate regressions. All models absorb fixed effects for birth municipality, year-month of birth, spacing in months to younger sibling, second generation immigrant status, maternal age at birth, paternal age at birth, maternal level-field of education, paternal level-field of education, and age at last educational observation.